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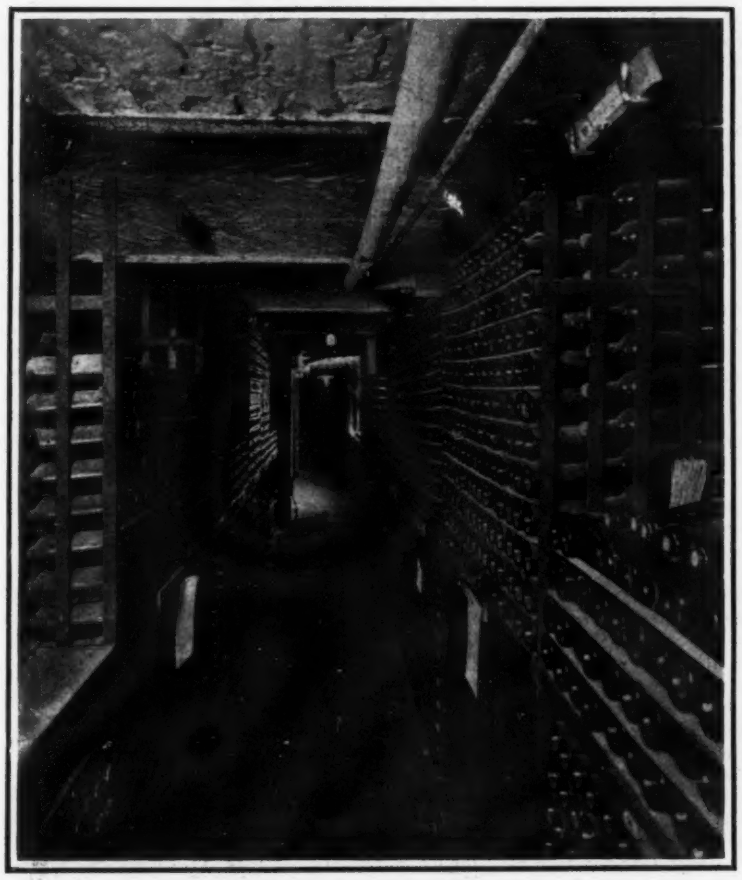
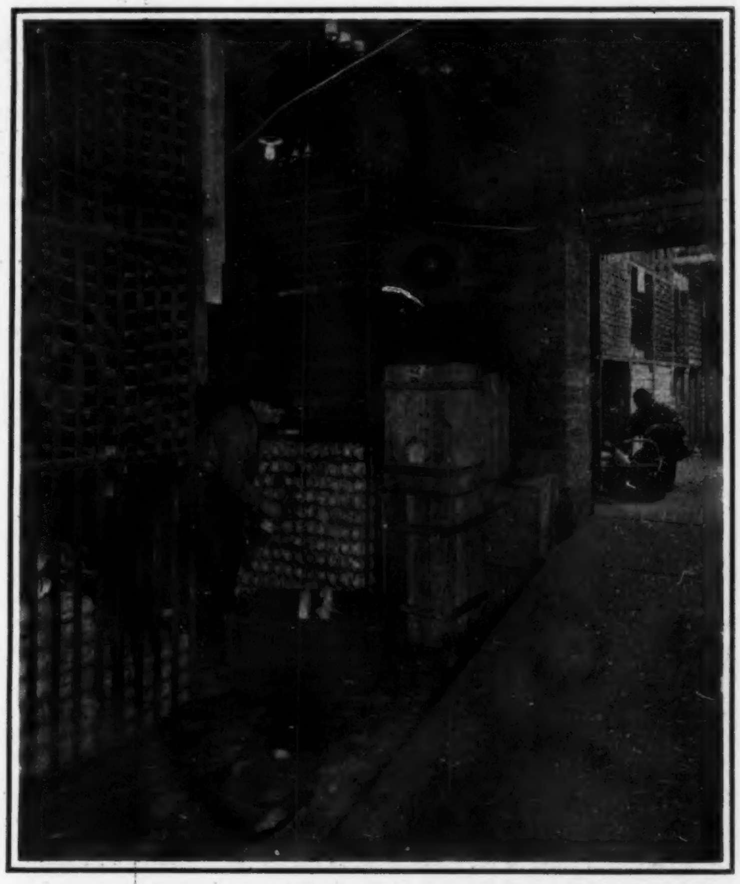


IN THE CELLARS WHERE BORDEAUX WINE IS STORED.



THE CHAMPAGNE AND WHITE WINE CELLARS.

THE MOSELLE WINE CELLARS.

WINE CULTURE IN GERMANY.—[SEE PAGE 392.]

GASOLINE AND ALCOHOL ENGINES.*

COMMERCIAL DEDUCTIONS FROM COMPARISON TESTS.

BY ROBERT M. STRONG.

Continued from Supplement No. 1771, page 379.

EFFECTS OF PRINCIPAL OPERATING CONDITIONS.

EFFECT of Different Loads.—The fuel-consumption ratios given above for alcohol and gasoline (1.45 to 1 and 1 to 1 by volume) are little affected by the load when the other operating conditions are limited to the best for each load. This limitation requires continual change in the time of ignition and in the quantity of fuel supplied, as regulated by the igniter and the fuel needle valve, with a correspondingly wide difference in the numerical values obtained for the minimum fuel-consumption rates for the different loads. Thus the minimum consumption rate of gasoline and alcohol for the maximum load is about 10 per cent greater than that for the best load, which is usually about 80 to 85 per cent of the maximum load; while the minimum fuel-consumption rate for light load, say about one-third load, may be anything greater than that for best load, depending on the disturbing effect of the governor. With the engines used for this investigation, the minimum fuel-consumption rate for one-third load was approximately 50 per cent greater than that for best load.

Effect of Mixture Quality.—For gasoline and alcohol alike, the ratio of air to fuel for the condition of minimum fuel consumption at maximum load was found to be approximately that for a chemical mixture, that is, theoretically just sufficient air for complete combustion in each case. This ratio for gasoline is approximately 15 parts of air to 1 of fuel by weight, and for denatured alcohol (90 per cent ethyl alcohol), approximately 8 parts of air to 1 of fuel. The minimum fuel-consumption rate at best load (about 80 per cent of maximum load) was obtained with a mixture of between 19 and 23 parts of air to 1 of gasoline by weight, and of between 9½ and 11½ parts of air to 1 of alcohol by weight, when used at the same compression pressures; that is, for the most economical use of gasoline and alcohol at the same compression the calculations show that from 25 to 50 per cent excess air was used, depending on the estimated mixture temperature.

From a series of observations of the temperatures of the fuel and air mixtures as they enter the cylinder of the engine, and from measurements of exhaust temperatures for various conditions of operation, a careful estimate was made of the temperature of the ultimate mixture in the cylinder at the beginning of the compression stroke. For the condition of minimum fuel consumption for loads from maximum load to somewhat below best load (about 75 per cent of the maximum load) these estimates show a range of ultimate mixture temperatures from not to exceed about 160 deg. F., if no vaporization of fuel takes place in the cylinder, to not less than 60 deg. F., if all the fuel is vaporized in the cylinder.

The average weight of fuel per charge was obtained from the fuel-consumption rate and the average number of fuel admissions per minute, from which the corresponding volume of fuel per stroke was calculated. The volume of fuel and air mixture per stroke was calculated from the piston displacement, multiplied by a factor obtained from the light spring indicator diagram of the suction and compression stroke. These diagrams, if taken carefully, show accurately the volumetric efficiency of the pump action of the engine. Such, in brief, were the data used in determining the air-to-fuel ratios stated above, and a careful study of all the conditions affecting them indicates that the actual values lie about midway between the limits given.†

The accuracy of the foregoing method of determining the mixture quality may be questioned, but, be that as it may, for every load there is some best mixture quality and for every mixture quality there is some best time of ignition. But the mixture quality may not be constant for any given load, because there is a disturbing effect if a hit-or-miss governor attachment is used, and the throttling method of governing complicates matters by affecting the compression. From maximum load to about 80 per cent of the maximum, with the best time of ignition, the best mixture is the weakest that will make the engine carry the load. Using such a mixture automatically eliminates the disturbing effect of the governor; or at least the effect is minimized and made constant when the mixture is such that only sufficient governor action is obtained to carry the load satisfactorily under reasonably constant conditions. At about 80 per cent of the maximum load the weakest mixture that will carry the load approaches the limit of dilution with air, beyond which it becomes nonexplosive for the conditions under which it is used in the engine; hence for the light loads the disturbing effect of the governor makes the mixture quality irregular, and may be such that the best results will be obtained with the fuel needle valve much wider open than for the heavier loads.

The extent of the irregularity of the mixing can readily be seen by inspection of series of indicator diagrams taken on the same card. If the hit-or-miss method of governing is used, the irregularities caused by the governor action will be seen clearly in a series of diagrams taken from cut-out to cut-out, or for about the first ten explosions after cut-outs. Such a series also illustrates the fact that when the mixture is irregular the time of ignition, though regulated to give the best ultimate results, is by no means the best for each individual charge of explosive mixture. This may account in part for the fact that the minimum fuel-consumption rate is increased when irregular conditions are caused by the governor action with light loads.

Effect of Time of Ignition.—Ignition at or near dead center will give the best results in some cases, as for maximum load, while in others ignition as early as 35 deg. before dead center will be found best. No general rule can be given. The best time of ignition can be judged to a certain extent by inspection of the indicator diagrams, and seems to be relatively earlier for alcohol than for gasoline.

The rate of flame propagation is different for different ratios of air to fuel vapor. A very rich explosive mixture or a very lean one burns slowly as compared with those of intermediate ratio. The rate may depend somewhat on the pressure at the time of ignition and may be different for alcohol and gasoline mixtures. The indications are that the rate of flame propagation for alcohol mixtures is slower than that for gasoline mixtures of the same relative quality compressed to the same pressure, but may be practically the same when the best compression pressure for each fuel is used.

Providing an ignition device such that the time of ignition can be varied from about zero, or dead center, to about 35 deg. advance, is almost as important for obtaining the best results as providing a fuel needle valve so constructed that a wide range of mixture quality can be obtained; for, as previously stated, it is the best mixture quality with the best time ignition that must be determined for different loads; and this mixture is considerably richer for maximum load than for rated or best load when the governor action is constant.

If the construction of the engine is such that the time of ignition cannot readily be varied for each load to suit the best mixture quality, the point to be considered is not that for every mixture quality there is some best time of ignition, but rather that for a given time of ignition there is some best mixture quality. The fixed time of ignition affects the fuel-consumption rate of the engine by limiting the quality of mixture that can be used.

Tests with Variable Load.—The load, then, may affect the fuel-consumption rate of an engine by limiting the mixture quality that can be used and by determining the irregularity caused by the method of governing. The relation between load, mixture quality, and time of ignition is very complex. The best combination could be determined only by series of systematic tests. Such tests were made to determine the minimum consumption for each engine with each fuel, with each carbureter used, etc., and for each imposed independent condition of operation, such as speed or compression.

Thus, in obtaining the foregoing consumption rates and ratios, 14 series of tests were made to determine the minimum fuel-consumption rate for each of an average of about five loads, from maximum load to approximately one-third maximum load, on five different engines, with different carbureters, methods of governing, and degrees of compression.

Four of the 14 series of tests were made with gasoline on three different engines. Two of these were 15-horse-power Otto gasoline engines of identical size, construction, and equipment. The third, a 10-horse-power Nash gasoline engine, was totally different in method of governing and detail of carbureter construction. Two series of tests with gasoline were made on this 10-horse-power engine, but with different carbureters.

Five engines were used for the ten series of alcohol tests, of which two were made on the 15-horse-power Otto gasoline engines and a third on one of these engines after the degree of compression had been raised as much as possible by lengthening the connecting rod. The fourth, fifth, and sixth series of tests were made on a 15-horse-power Otto alcohol engine of identical size with the Otto gasoline engine, but with a different valve arrangement and method of governing. A different degree of compression was obtained for each of these series of tests by lengthening the connecting rod. The seventh and eighth series of tests were made on a 10-horse-power Nash gasoline engine with two different carbureters. The ninth and tenth series of tests were made on a 10-horse-power Nash alcohol engine, which was identical in size, construction, and equipment with the 10-horse-power Nash gasoline engine, the only difference being that a higher degree of compression was obtained by diminishing the clearance space in the cylinder head. Different carbureters were used for the two series of tests on this engine.

Tests with Change in Time of Ignition.—Two series of tests, consisting of nine individual tests with alcohol and nine with gasoline, were made on the 15-horse-power Otto gasoline engine to determine the effect of change in time of ignition on the fuel-consumption rate when the load and fuel needle-valve setting were kept constant. The load and needle-valve setting selected were such that a wide range of ignition timing could be used.

For the gasoline tests the load was 85 per cent of the maximum. The best results, a consumption of 0.66 pound per brake horse-power per hour, were obtained for an ignition timing of 13 deg. before dead center. For an ignition timing of 21 deg. before dead center the fuel-consumption rate was increased 9 per cent, and 36 per cent for an ignition timing of 15 deg. after dead center.

For the alcohol tests the load was 79 per cent of the maximum. The best results, a consumption of 1.1 pounds per brake horse-power per hour, were obtained for an ignition timing of 25 deg. before dead center. For an ignition timing of 30 deg. before dead center the fuel-consumption rate was increased 4 per cent, and 6½ per cent for an ignition timing of 5 deg. after dead center.

The time of ignition was carried to the limit both ways for each fuel, the limit being the earliest or latest ignition with which the engine would carry the load satisfactorily. The disturbing effect of the governor was thus not constant, but it was comparatively slight throughout and the irregularity was probably not appreciable.

Tests with Variable Fuel Supply.—Four series of tests with gasoline and alcohol were made on the two 15-horse-power Otto gasoline engines. The conditions for two of these series with gasoline and alcohol respectively were as follows:

For the tests with gasoline a brake load of 85 per cent of the maximum was applied, and the time of ignition selected (21 deg. before dead center) was such that the widest possible range of fuel needle-valve settings for this load could be used. Starting with the minimum opening of the fuel needle valve and a corresponding rate of fuel consumption of 0.62 pound per brake horse-power per hour, the fuel needle-valve opening was increased until the engine could scarcely carry the load, as indicated by the governor action. This fuel needle-valve setting gave a consumption rate of 1.31 pounds per brake horse-power per hour, or an increase of 110 per cent.

For the tests with alcohol a brake load of 79 per cent of the maximum was applied and the time of ignition selected (17 deg. before dead center) was such that the widest possible range of fuel needle-valve settings for this load could be used. Starting with the minimum opening of the fuel needle valve and a corresponding rate of fuel consumption of 1.1 pounds per brake horse-power, the fuel needle-valve opening was increased until the maximum opening was reached. This fuel needle-valve setting gave a consumption rate of 1.6 pounds per brake horse-power per hour, or an increase of 45 per cent.

When the results of these tests were plotted, showing the relation between the brake horse-power and

* Bulletin published by United States Geological Survey.

† A more detailed discussion of this feature of the investigation has been prepared in the final report.

the rate of fuel consumption, the results obtained for six intermediate fuel needle-valve settings were found to lie on a straight line between the values given above in each case. As the load was kept constant the disturbing effect of the governor was not eliminated, but probably was slight, as shown by the indicator diagrams.

The other two series of tests were made in a similar way, but with a light load, so that the disturbing effect of the governor was relatively great. In these tests, 11 each for gasoline and alcohol, the needle-valve settings were not carried to the limit either way, but only so far as was necessary to show that for light loads the minimum fuel-consumption rate is not obtained with the smallest possible fuel needle-valve setting, the best setting being rather that which gave the most nearly uniform mixtures, as shown by the regularity of the shape of the successive indicator diagrams. This was also found to be true when the best ultimate settings were determined for the light loads.

Incidental Material.—In all, 1,300 tests, including trial tests, were made to determine the foregoing deductions and figures. The detailed results of these tests afford an opportunity to study the effect of degree of compression, mixture quality, and time of ignition on the fuel-consumption rate, and include a great deal of incidental material, such as indicator cards, maximum-pressure measurements, temperature records for fuel and air mixtures entering the cylinder, and the like. The fuel-consumption rates are given in pounds, gallons, and British thermal units per brake and indicated horse-power per hour. Mechanical efficiency, indicated thermal efficiency, and thermal efficiency of the brake are also given. But these tables are too bulky and involved to present at this time. The trial tests have been prepared in condensed form for the final report, and thus present some interesting and important information, showing what difficulty was experienced in determining the best ultimate results in some cases.

LIMITS OF FUEL-CONSUMPTION RATES.

Limits Set by Operating Conditions.—So wide is the range of adaptability of alcohol and gasoline to the operating conditions governing or limiting the performance and fuel consumption of internal-combustion engines, that for engines operating under different conditions the ratio of the rates of consumption of the two fuels per unit of power may be almost anything, even the reverse of their heating values; that is, even though the two engines are in good running condition and operating perfectly to all outward appearances, are of the same size, with compression regulated to that best for their respective fuels, and carry the same percentage of maximum load, the operating conditions may be made such that the engine run with gasoline will use twice as much fuel in pounds per brake horse-power per hour as the alcohol engine. Such a ratio is quite likely to be obtained in practice from off-hand comparison of the performance of two engines; but obviously such a comparison would be meaningless.

When an engine is running at maximum load and governing for constant speed, only about 50 per cent excess alcohol can be supplied without causing the engine to slow down and stop; while at half load about two and a half times the amount needed can be supplied before the engine will show any outward change in operation, except that possibly an odor of alcohol or formalin in the exhaust will indicate to the operator that an excess of fuel is being supplied. An oversupply of alcohol does not produce an exhaust of black smoke, as does an excessive supply of gasoline; yet the percentage of excess of alcohol and gasoline that can be used without being detected outwardly is approximately the same. The maximum percentage of excess of gasoline that can be used at maximum loads is a little greater than that for alcohol. With light loads alcohol is likely to be used in greater excess, because the smoke is absent that with gasoline indicates any great oversupply.

With the stationary engines which govern for constant speed the following general rule of adjustment for minimum fuel consumption will hold in almost every case for loads from about half load to maximum load, if the engine is in good mechanical condition: Adjust the time of ignition and fuel needle valve so that the least possible amount of fuel is admitted per stroke without reducing the speed of the engine. In order to obtain the minimum fuel consumption for the gradation of loads from maximum down to about half load, a continuous reduction of fuel supply with earlier time of ignition will be necessary; that is, the smallest quantity of fuel supplied per stroke that will carry the load will give the minimum fuel consumption when the best time of ignition, which changes with the quality of the mixture, is used.

When the above rule is applied to obtain the minimum fuel-consumption rate for the maximum load that the engine is called on to carry, the fuel needle valve and igniter settings found to be the best will, in most cases, be nearly the best possible settings for all other loads down to about half load; at least the best constant setting condition that can be obtained for a varying load between those limits.

With the hit-or-miss method of governing, even though the number of fuel admissions per minute be a maximum, that is, though the number of cut-outs be only sufficient to insure certainty of operation, depending on the fluctuation of load, and though nearly every first fuel admission after cut-outs misfire on account of too weak mixture, the adjustment stated may be the most economical.

With the throttling method of governing, when the disturbing effect of the governor is minimized, the above rules will hold for all loads down to about one-quarter load and lower in some cases.

The foregoing deductions in reference to the maximum and minimum rates of fuel consumption are made from the results of four series of tests with gasoline and alcohol on the same engine (15-horse-power Otto gasoline engine) and subsequent incidental observations on the other engines using alcohol with the higher degrees of compression. Two previously determined series of tests on the same Otto gasoline engine, consisting of 158 and 220 single tests, respectively, were taken to obtain the minimum consumption rate of gasoline and of alcohol for seven and ten loads, respectively, between maximum load and about one-third maximum load, and two additional series, of 13 and 24 tests, respectively, were made to determine the maximum rate of gasoline and of alcohol consumption for seven loads covering the same range. Later, when tests were made with alcohol on the Otto alcohol engine and the degree of compression greatly increased, it was found that the maximum amount of alcohol that could be used with the higher degree of compression was very much less for the same percentage of maximum load; but the percentage in excess of the minimum quantity that could be used was practically the same.

Deductions relating to constant engine settings were made from 12 series of tests with an average of about four different loads for each set of fixed conditions. Four of these experiments were made with gasoline and eight with alcohol. Some of them were made with the fuel needle valve and igniter settings which gave the minimum fuel-consumption rate for the maximum load which the engine would carry, while others were made with the settings which gave the minimum fuel-consumption rate for the load with which the best results were obtained (about 85 per cent maximum load). These settings were kept constant for each experiment or series of tests.

The results of the tests with constant engine settings were used in conjunction with the results of the tests which were made to determine the minimum fuel-consumption rate for each different load, and in which the fuel needle-valve setting and time of ignition were varied accordingly. This comparison was made in order to show the relation between the constant settings and best settings for the various loads, as indicated by the ultimate results expressed in pounds of fuel consumed per brake horse-power per hour. Tables giving details of the tests, and curves illustrating the wide range of results that may be obtained between the limits of operating conditions, have been prepared for the final report.

Limits Set by Engine Design.—The limiting effect of engine conditions on the relative adaptability of gasoline and alcohol—that is, the limiting effect of the fundamental principles of engine and carbureter design and construction which are not under the control of the operator—may be eliminated to a great extent in the consideration of the comparative consumption of the two fuels. Some engines operating under varying loads may be a great deal less economical than others, owing to different methods of governing or the like, though all other conditions be equal. But the best practical engine conditions have been thoroughly worked out by many of the builders of high-grade gasoline engines, and though the average rate of consumption of either fuel may be almost anything greater than some one minimum figure which depends on both engine and operating conditions, the same approach to the minimum consumption figure for each fuel can be obtained with the same degree of skill in operating and the same care in design and construction, alike for gasoline and alcohol engines, regardless of many of the little details of design, construction, and equipment, which distinguish them and may otherwise affect the average rates of fuel consumption.

At present the skill in operating, designing, and constructing engines for the use of alcohol may not be so great as for gasoline engines. The average operator and engine builder in this country has had less experience with alcohol than with gasoline. Since this is a difference that will, however, vary with the relative use of alcohol and gasoline, and since one pint of gasoline per brake horse-power per hour may be given as a fair average consumption for an engine when operated at about rated load and under favorable conditions, a like figure can reasonably be expected for alcohol when a like understanding of its use is attained and engines as well adapted to its economical use are constructed. This conclusion is based on the results of tests on stationary engines of medium speed and size. The indications are, however, that the ratios given would remain the same, or possibly change a little in favor of alcohol, were all the engine conditions worked out to their most advantageous limit and the exact effect on the fuel consumption determined.

(To be continued.)

SCHIST BRICKS

THERE is beginning to be practised in various countries, particularly in Germany and England, an industry which was hitherto little known, and which, moreover, permits the recovery of a large part of the *débris* which is to be found around mines, which are not worked or which are filled up with rubbish. We refer to the manufacture of schist bricks. It cannot but be surprising that schist, and particularly schist from deposits of coal, should be used as a raw material for the manufacture of bricks. This schist, however, is nothing other than clay which has been strongly compressed, although it contains in addition, it is true, a small quantity of ferruginous matter and a little carbon. In addition to this, one does not have to be contented with the utilization only of the schist; for there occurs therewith a rich clay which changes its composition, fortunately, in proportion to the amount thereof. But this mixture of better quality is reserved for bricks which are to be used in the façades of buildings or those which are to be specially worked up for moldings, etc.

Naturally, in order to employ this stony raw material, it must first be pounded up and then pulverized, which is ordinarily done in a vertical stamping mill. The material may then be worked into a dry paste (to use the technical expression). The pulverized schist is then sent directly to a press of a special type, where the compression is exerted from below upward, and where the pistons stop for an instant, before finally reaching the end of their movement, to allow the air to escape from the pulverized material.

In preparing the semi-soft paste, the powder is treated in a suitable vessel with a little water; then it descends through a vertical cylinder, whence it is carried away by an endless screw, but begins to receive at the same time a compression. The paste is forced into a series of molds, disposed about the circumference of a revolving table; a piston descends then, compressing the paste in each one of the molds, and the manufacture of the bricks is completed after their passage through the special press before referred to.

The schist bricks are baked in furnaces without preliminary drying, but after having been exposed for a certain length of time to the gases from this furnace.

The schist bricks are well thought of by architects and manufacturers, and it is held that some are able to withstand the same resistance as the better of the older kind of bricks.

INCANDESCENT PETROLEUM LAMPS FOR LIGHTHOUSES.

IN the "Lux" system of illumination kerosene is forced through a vaporizer at a pressure of 2.3 atmospheres and the vapor is burned in a Bunsen burner, where it heats a mantle to incandescence. In the first trials of this system the pressure was furnished by cylinders fitted with carbon dioxide at a pressure of 70 atmospheres, but the difficulty and expense of transporting the cylinders to an isolated lighthouse led the managers of the lighthouse at Leghorn, Italy, to substitute compressed air. An empty carbon dioxide cylinder and a hand pump were employed, and it was found sufficient to charge the cylinder daily to 5 atmospheres, which represented twice the daily consumption. The lighthouse had previously been lighted with acetylene, the lamp having eight burners. The new system was found to give a much brighter light, the exact intensity of which has not yet been measured. Nine hundred and six pounds of kerosene were consumed in 1,235 hours, or less than ¾ pound per hour, and the expense for fuel was less than half that incurred in the acetylene system. The mantles lasted more than 20 days when everything worked properly, but their average life could not be estimated exactly, because they were destroyed, in most cases, by some irregularity in operation or defect in cleaning. The burners were rapidly destroyed by the high temperature, but they cost only 10 cents each. The operation of the apparatus is not difficult, but constant surveillance and perfect cleanliness are required. The vaporizers become clogged in about two weeks, but are easily cleaned by forcing air through them at high pressure. The apparatus is subject to far less rapid deterioration than the acetylene apparatus, which is corroded by the acids formed in the hydration of the calcium carbide.

A PORTABLE DANISH OIL ENGINE.

A NEW FORM OF LOCOMOBILE.

BY FRANK C. PERKINS.

THE accompanying illustration and drawing show a Danish locomobile or portable oil engine of 10-horse-power capacity as constructed at Fredrikshaven. The entire equipment is mounted on a four-wheel truck, and includes a vertical engine designed to operate at a speed of 380 revolutions per minute. It has a flywheel 116 centimeters in diameter. There is provided on the same truck a water-cooling tank with fan and a water-circulating pump, together with an oil tank capable of holding about 150 liters of fuel. By the double injection of kerosene oil the power can be increased by about 50 per cent.

It is held that the oil consumption for this motor under normal conditions will not exceed ½ kilogramme per horse-power hour. The engine works with a vaporizer, which is provided with a special lamp, the heating of the incandescent head requiring from 6 to 10 minutes. As soon as the proper heat has been attained and the engine has been started, it is stated that the lamp may be removed, and the vaporizer and incandescent head will, by reason of the explosions, then maintain sufficient heat to ignite the mixture of air and kerosene oil.

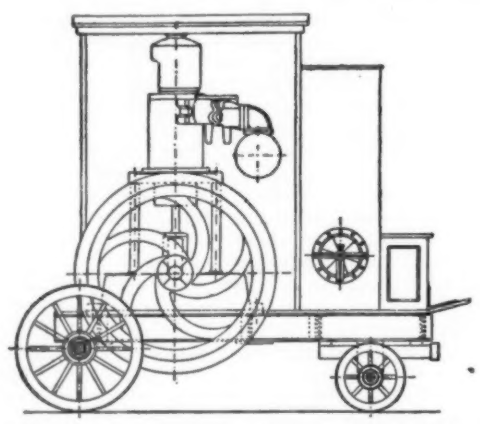


DIAGRAM OF PORTABLE DANISH OIL ENGINE.

A PORTABLE DANISH OIL ENGINE.

ALUMINIUM: ITS FUTURE AS A SUBSTITUTE FOR COPPER WIRE.*

By VAUGHAN H. WILSON.

THE most common of all the metal elements or base metals which make up the earth crust is aluminium, yet not until the past few years has it been put to any mercantile use owing to the expense of refining it, and the failure on the part of the public to recognize its possibilities. The metal was first separated from its compounds by Wohler, who succeeded where Day, Oerstadt, and Berzelius had failed, in 1828, and it was but little more than a laboratory product until 1853 when Deville made the first experiment which began the movement to bring it under the head of useful minerals. Under obsolete methods the cost had been $200 a pound. A company was formed by Deville, and it was produced so cheaply that it could be sold for $15 per pound. Since then modern methods of metallurgy have brought the price down to about 32 cents per pound.

Recently deposits of aluminium oxide have been discovered in Georgia, Alabama, New Mexico, Nevada, and Greenland. The working of aluminium deposits is no longer mainly limited to France and Germany.

In 1883 the American industry began and in 1906 the production was roughly 15,000,000 pounds. The present day uses of the mineral are far in advance of what they were a few years ago. Not only is it being used as an alloy with steel, silver, and copper, but it is beginning to take the place of silver and nickel in many lines, and is being seriously considered by leading engineers as an electrical conductor to supersede copper. Practically the only company that uses it for this latter purpose to-day is the Niagara Lighting and Power Company. Aluminium cables convey the power about the country, and the wires, nearly an inch in diameter, may be seen for miles along the railroad track coming east of the Falls.

Although this is almost the sole application on a large scale on this continent it has been tested and found satisfactory in many instances abroad. Numerous aluminium electric lines have been installed during the past four or five years by French electric power companies. The excellent results that have been obtained from a technical and economical point of view confirm the qualities of this metal and, in a measure, justify the prophecy that it will be a successor to copper.

Up to the present time copper has maintained its predominating position in the science of applied electricity because it possesses of all metals, with the exception of silver, the highest electrical conductivity. The comparatively high price of aluminium admitted its use for electrical purposes thus far only in a strongly rising copper market. This state of affairs was, however, completely changed a few years ago when aluminium became actually cheaper than copper. Under these new circumstances the question arises whether the replacing of copper by this metal will be advantageous for electrical purposes.

It seems to have been adequately proved by careful tests that neither in conductivity nor tensile strength are there insurmountable obstacles in the way of its application. To replace a copper wire of say 10 square millimeters cross section, which serves as a conductor of a current of 40 amperes, by an aluminium wire, the latter would have to be given a cross section of 17 square millimeters. In spite of the large cross section the aluminium wire of equal length is lighter than the electrically equivalent hard copper wire because the specific weight of the white metal amounts to less than one-third that of the red metal. On the basis of equal prices for the wire the saving would be over 48 per cent and this percentage would be even greater at the present market prices of the two elements. The tensile strength of aluminium is far below that of copper. The ratio is about 9 to 12. This difference is partly offset by the fact that the aluminium weighs less than a third as much as its rival, so that a materially smaller amount of strength is required. Practice has taught that the same spans can be used with aluminium wire as with copper wire.

There is only one feature which has aroused the apprehension of engineers. This is the difficulty of finding a reliable solder. Joints have been devised, however, recently which remove in most cases the necessity of solder. The MacIntyre joint seems to have considerable favor. Mechanical riveting, which has given excellent results with copper, can also be used on aluminium.

Disadvantages of a mechanical order have been charged against aluminium. It is thought that it would not withstand atmospheric conditions as well as copper, and that greater transverse strains would be thrown on the supports. Experiment has demonstrated that there is a negligible difference between aluminium and copper as regards resistance to snow and wind action. The other statement carries little in that for normal spans of 40 to 50 yards on wooden poles, the extra transverse strain is not noticeable.

A series of tests is now being made of alloys of aluminium and of metals of the same family. It is possible that a combination superior to the pure metal now in use may be reached. It is premature to dwell, however, upon this phase of the subject.

The potentialities of aluminium as a substitute for copper are gradually becoming accepted. With the acknowledgment of the truth of the theory involved will come the development along various lines.

* Yale Scientific Monthly.

THE LIMITS OF SENSITIVENESS OF THERMO-ELECTRIC BATTERIES.

IT is well known that the sensitiveness of thermo-electric batteries has been increased very materially of late, thanks to the possibility now existing of making wires of exceeding thinness. Thus a constantan-iron cell or element, connected with a needle galvanometer, each degree of which indicates 3×10^{-7}, is, according to Brandes (Phys. Zeitschr., vol. vi., page 503, 1905) capable of showing intensities of 2.1×10^{-8} amperes.

Now, Hartmann of Frankfort-on-the-Main has just produced exceedingly thin wires from new substances provided by Guillaume. By increasing the length of these wires as much as possible and by giving their soldered joints a minimum of surface, he has succeeded in obtaining a further considerable increase in the sensitiveness of thermo-electric batteries.

Following a suggestion made by K. E. Schmidt (Phys. Zeitschr., vol. x., page 438, 1909) one of his pupils has recently investigated systematically the limits to the sensitiveness of thermo-electric batteries with the means now at our disposal. This experimenter has ascertained that a cell composed of manganin and constantan wires of 0.0154 millimeter thickness and each about 2 centimeters long will constitute an extremely sensitive cell if a very high vacuum is employed. Connected with a mirror-galvanometer (of the Deprez-d'Arsonval type) of medium sensitiveness, this battery will measure currents of about 89×10^{-8} amperes. If the diameter of the wire could later be reduced 0.001 millimeter, it would be possible to estimate $89 - 16.5 = 72.5 \times 10^{-8}$ amperes; that is to say, each reduction of the diameter by one thousandth of a millimeter would correspond to an increase of 16.5×10^{-8} in the sensitiveness of the thermo-electric apparatus. This ratio, however, does not seem to remain the same for exceedingly small diameters. Since technical difficulties do not for the time being allow the diameter of the wire to be reduced further, a current of about 0.0001 ampere may be considered the present limit of the sensitiveness of thermo-electric batteries for rapid electric vibrations.—Revue Générale des Sciences Pures et Appliquées.

A BISMUTH MICROPHONE.

IN order that the carbon microphone should function well, it is indispensable, says L'Electricien, that the intensity of the current employed shall be maintained within limits which are relatively somewhat high. When this intensity becomes too high, there is produced on the line, as the result of the formation of arcs between the different contacts, and the agglutination of the particles of carbon, all sorts of strange noises; the transmission of sounds then becomes defective, indeed almost impossible. With a view to remedying this inconvenience, Mr. W. Münchenhagen, of Tempelhof, Germany, proposes the construction, with the help of a phenomenon hitherto employed in measuring instruments, of a microphone which will not be impaired by variable contacts. Under the influence of a phenomenon discovered by Mr. Righi, it is known that a spool of bismuth wire modifies its resistance in the magnetic field, so that this resistance increases with the augmentation of the intensity of the field, and that it diminishes in the measure and strictly proportional to the abatement of the same intensity. One provides a telephone with a spool of bismuth wire, in place of a spool of copper wire, and places this spool upon the poles of the permanent magnet; the telephone thus modified is used as a microphone. If one speaks into a similar telephone, the intensity of the field of the permanent magnet is modified according to the vibrations of the iron membrane, and in similar manner the resistance of the spools of bismuth wire vary. These variations of the current are reproduced then as in the microphone hitherto employed, and since the microphone with the spools of bismuth are not affected by variable contacts, one eliminates the disadvantages inherent in ordinary microphones. There may thus be employed, at will, any intensity whatsoever, provided the limit corresponding to the section of the bismuth wire used is not exceeded. Mr. Münchenhagen has remarked that this is formulated only as a proposal, and that it is proper first to determine, by more penetrating investigations, if the principle here given is exactly correct, and if it is possible of realization by means of a convenient construction.

TIME SPEED CONTROL SIGNALS.

HOW AUTOMATIC DEVICES PREVENT RAILWAY COLLISIONS.

BY GEORGE S. HODGINS.

A BULLET fired from a rifle into a heap of sand or earth enters the breastwork at a certain velocity, but as it penetrates the yielding substance of the mound, it gradually loses its force, and after having burrowed inward some distance comes to rest. The entrance at high speed and the gradual loss of velocity is, in a certain sense, analogous to a very cleverly devised arrangement used in the New York Subway for advancing a train with decreased velocity through a long block up to the point of ultimate stop.

The Ninety-sixth Street and Broadway station on the Interborough line is really a junction point where the trains for the northern part of New York on the West Side and those for the Borough of the Bronx deviate from the trunk line running up from Brooklyn and the lower part of the city. This junction has a

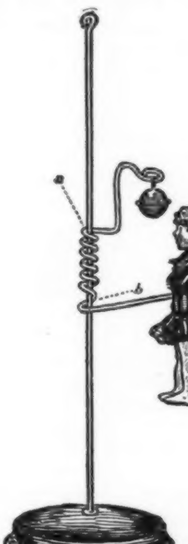


FIG. 1.—DANCING DOLL.

regularly interlocked system of signals and power operated switches, but it has formed what may be called the "neck of the bottle" as far as operating the road is concerned, where expresses and locals converge in the south-bound train movement and where the up-town locals and expresses are switched to their tracks. The arrangement of which we write is designed to remove the "choking" at the bottle neck during the rush hours, morning and evening.

Under the direction of Mr. Frank Hedley, vice-president and general manager of the Interborough, the signal engineer, Mr. J. M. Waldron, has perfected a very ingenious plan for governing the approach of trains to the Ninety-sixth Street station. Mr. Waldron recently patented this arrangement. On account of the formation of the tunnel north of this station, under Broadway, both south-bound local and express trains are compelled to traverse a single track for a distance of something over one-eighth of a mile. At the entrance to the station the expresses are turned on to the south-bound express track and the locals reach the south-bound local track. Similar conditions exist for the up-town express and local traffic. All four tracks are equipped with these time control signals, but for sake of clearness we may consider one of them here.

cause, the disobedient train would be automatically brought to rest by the action of the stop signal before it could strike a train using the cross-over.

This arrangement was pre-eminently safe, but there was nevertheless a loss of time, after the departure of the train in the station, before the following train could take up its position at the platform. This was owing to the second train, stopped at the far signal, requiring a certain time to pass through the block up to the interlocked signal and so into the station.

The problem to which the subway officials applied themselves was to devise ways and means by which this delay could be avoided, and which would enable the following train to creep up to the threshold of the station while the platform was already occupied. This had to be accomplished without the sacrifice of safety in any way, and the provision of the full braking distance ahead of the oncoming train which was required for its speed.

Briefly stated, the problem was solved by the combination of the signal, the automatic stop, and the time-lock principle which is used at various interlocking signal plants in many parts of the country. The far away and the interlocking signals were moved farther from the station and four new signals were installed. A word may be said about this time-lock, which will perhaps make clear its operation in the New York Subway. The reader must, however, bear in mind that while the principle here described is made use of at the Ninety-sixth Street junction, the mechanism is necessarily modified to suit the particular requirements of the case.

The principle of the mechanical time-lock, as made by the Union Switch and Signal Company, is very simple and in a sense it embodies the principle ingeniously adapted by toy-makers to the little dancing doll which is commonly sold on the streets. The dancing doll is a little china figure, shown in our illustration, about 2 inches high and is supported by a small steel wire standing out at right angles to the body, the other end wound in a loose coil around a straight piece of wire. When at rest, the top of the coil remote from the doll touches the upright wire at *a*, Fig. 1, and the bottom of the coil at the junction of the supporting wire *b* also closely hugs the upright stem. To make the doll "dance" the loose coil is easily slid up the vertical wire and the doll released so that a vibratory motion is imparted to it. The springiness of the supporting wire and the alternate slip and jamb of the loose coil on the stem are sufficient to prevent any continuous slide of the little figure. Its center of gravity is so far away from the line of support that the up-and-down vibrations of the doll continue during its entire course down the rod. As much as ten seconds may thus be occupied by the doll in traversing the distance, up which it can be drawn in a fraction of a second.

The mechanical time-lock used in the subway is within the signal case, and though it has no external or entertaining feature like the doll, it nevertheless depends upon the time a vertical bar takes to descend when hampered in its fall by oscillating mechanism, and the bar, like the dancing doll, can be raised to the desired height in the fraction of a second. In Fig. 2, *A* is a vertical rack-bar engaged with the teeth of the small center ratchet wheel. The long teeth of the ratchet wheel engage with a pawl attached to the gear wheel *C*. The teeth of this wheel mesh with a pinion, *D*, which has a small clock-work escapement wheel keyed on the same shaft. The escapement and pendu-

short drops and halts, for the vertical bar, *A*. As much as a minute, if necessary, may be occupied in letting *A* sink down to its lowest position, from which it may have been raised in something less than a second. In the subway adaptation of this time-lock, the raising of the bar, *A*, up to the desired height is done

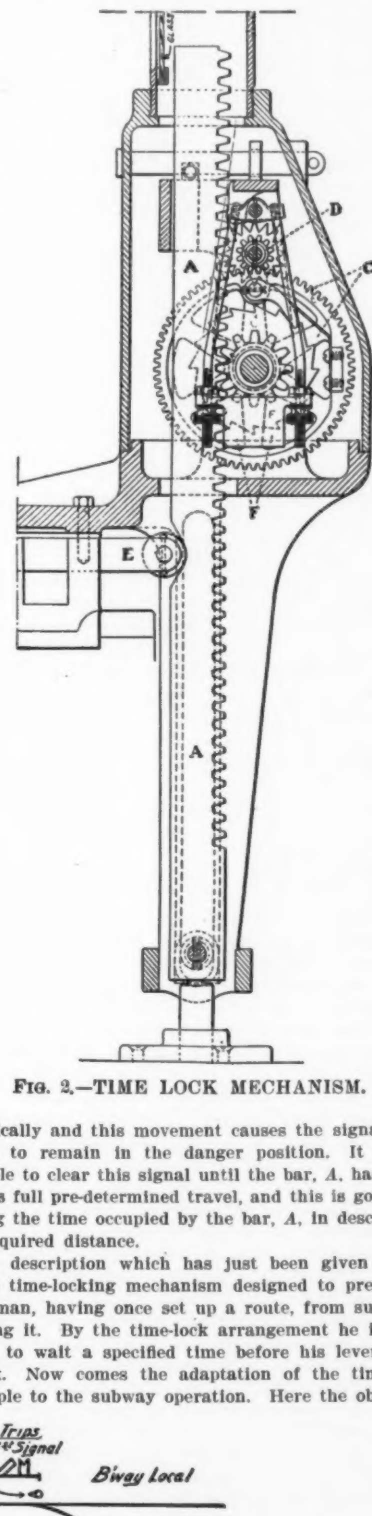


FIG. 2.—TIME LOCK MECHANISM.

electrically and this movement causes the signal next ahead to remain in the danger position. It is not possible to clear this signal until the bar, *A*, has dropped its full pre-determined travel, and this is governed during the time occupied by the bar, *A*, in descending the required distance.

The description which has just been given refers to the time-locking mechanism designed to prevent a towerman, having once set up a route, from suddenly altering it. By the time-lock arrangement he is compelled to wait a specified time before his levers will unlock. Now comes the adaptation of the time-lock principle to the subway operation. Here the object is

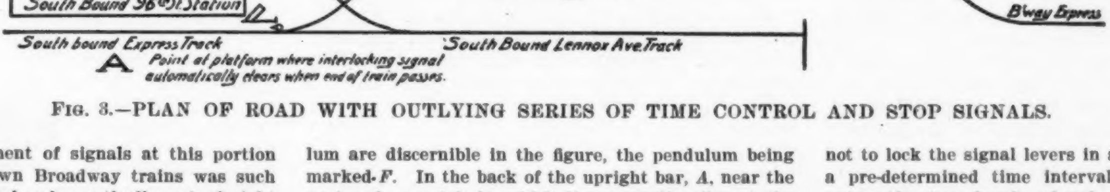


FIG. 3.—PLAN OF ROAD WITH OUTLYING SERIES OF TIME CONTROL AND STOP SIGNALS.

The former arrangement of signals at this portion of the line for down-town Broadway trains was such that a stop signal was placed practically out of sight of the interlocking signal at the crossing point of the tracks, and when the station was occupied by a train, the train following was compelled to halt the full distance of this block away from the station. This arrangement provided a braking distance of over 600 feet to the crossover tracks for a speed of 40 miles an hour, so that if this stop-signal was overrun for any

lum are discernible in the figure, the pendulum being marked *F*. In the back of the upright bar, *A*, near the center, is a notch in which lies a small roller at the end of a locking-bar, *E*. As *A* rises the locking-bar is moved to the left and remains in that position until notch and roller again coincide, after *A* has run down to its original position. When once the bar, *A*, has been raised, the pawl has carried the wheel, *C*, around, and causes the pendulum to vibrate, and this compels the escapement to step off a long series of consecutive

not to lock the signal levers in a tower, but to provide a pre-determined time interval between a series of automatic stop signals, placed comparatively close together.

For example, an express in the subway approaches the first signal which normally shows clear in the upper light, no matter whether the station is occupied or not. The lower light shows clear if the station is empty, but displays the caution light if the station is occupied. The express train has therefore, in any case,

the right to proceed past this signal. This signal, by reason of its lower light showing "caution," indicates that the station is occupied, and all the intermediate signals in the system we are considering, show red in the upper light and yellow in the lower. If, however, the station is not occupied by a train, both lights of the first signal, and those of all the signals between it and the interlocking signal, show clear. If the express train of which we speak approaches the first signal, and finds that it shows green in the upper light, and yellow in the lower, the motorman knows that the station track for which the route is set, or the cross-over track, is occupied by a train.

The arrangement of these signals is such that whether a train is standing on the express or local tracks at the station, the outlying string of approach signals will show red in the upper light and yellow in the lower, or they will all show clear, according as the cross-over switches are set for the express or the local tracks. If a train is occupying the local track at the station, and the towerman has thrown the cross-over switches for the empty express station track, the system of signals will show clear, as an on-coming train cannot then collide with the standing train on the local track. Similarly if the express track at the station is occupied and the local track is empty, this signal system will show clear as soon as the cross-over switches are set for the local track.

The towerman is always able to set up either the express or the local route, as soon as a train passes the signals at the end of the station platforms, placed one on the express, and one on the local track. The interlocking signal for the unoccupied track is cleared when a train has drawn in past the signals at the end of the station platform. The passing of a train over the cross-over tracks causes the whole of this system of signals to indicate "danger," and put the time-governing mechanism into operation. It is thus possible to move a south-bound local train from the Lenox Avenue track over the cross-over tracks, if the local station track is empty, and at the same time, to advance a south-bound Broadway express through the short outlying blocks at reduced speed, up to the interlocking signal. The location of this interlocking signal is such as to maintain the required braking distance, for the reduced train speed between the interlocking signal and the fouling-point of the cross-over tracks.

The green upper light in the first signal gives the motorman the right to proceed, and the passing of this signal causes the time-lock mechanism to operate, and if the route is set for the station track which is already occupied, this mechanism will prevent the second signal from clearing for 5 seconds after the moving train has passed the first signal, and the second signal trip will remain in the stop position for that time. The second signal, which would otherwise remain red with automatic stop raised, will actually clear and lower the trip after the time limit of 5 seconds. The lower light of the second signal still showing yellow indicates that there is a train in the station on the track for which the route is set, or that the cross-over tracks are occupied. The moving train must therefore so regulate its speed that the second signal will clear before it is reached.

The distance between the first and the second signal is 150 feet, and this insures that a reduction of speed necessarily must take place in passing through this first short block. In fact, if the first signal is passed at 35 miles per hour, the train will require to reduce speed with an average loss of velocity of about 22 feet per second for the 5 seconds in which the automatic trip of the second signal is held up while the signal light indicates "stop." The speed of the train through this first block must therefore be reduced to an average of 20 miles an hour.

The successful passing of the second signal operates the timing mechanism, and the third signal remains at danger with its trip in the stop position for a period of 10 seconds after the second signal has been passed. The initial speed, reduced as it was at the entrance of this block, is again necessarily further reduced in passing over the 215 feet which separates the second and the third signals, and this brings the speed down to an average of 13½ miles per hour. The same operation is repeated between the third and fourth signals, which latter requires 9 seconds before it will clear. This brings the average speed down to 6¼ miles per hour. The distance between the third and fourth signals is 120 feet. After passing the fourth signal the train has 125 feet ahead of it before the interlocking signal is reached. The result of this is that the train is compelled to approach the interlocking signal at about 6½ miles per hour, at which speed, if the interlocking signal with its upraised trip was overrun, the moving train would be stopped before it could reach the fouling point of the cross-over tracks. The clear distance ahead of the train at each signal in this system is more than the required braking distance for the speed demanded by the signal.

The arrival of the moving train at the interlocking signal when halted, brings it up to the very threshold of the station, and when it gets this signal clear, authorizing its entrance to the station, it is but a short distance from the platform, and the lost time hitherto required to bring it from the first signal in the series is now eliminated, and a gain of 25 seconds in each train movement is thus secured. The time speed-control arrangement operates to provide what may be called a "conditional advance" for a following train when either track in the station is occupied by a train at the platform or when a train is passing over the cross-over track. The "condition" imposed by these comparatively closely-spaced stop signals is that the distance separating them shall be traversed by a moving train in a specified period of time, which necessarily implies the required reduction of speed in each short block. Disregard of any one of the time-governed signals brings about an automatic stop with an emergency application of the brake. In this way a safe advance of the train is secured up to what we have called the threshold of the station, which is the interlocking signal, and the automatic signals stand like silent but watchful sentinels imperiously demanding the sign manual of reduced speed before permitting friend or foe, express or local, fast or slow train to pass.

There is, however, another condition which is met by this cleverly devised arrangement of stop and time-requiring signal operation. In case there is no train occupying the express or local track in the station, the entire series of "sentinel" signals, if one may so call them, shows clear, and the passing of the first, or any of them, does not operate the time-governed mechanism, and the moving train may proceed into the station without consuming the longer time required when the speed-controlling mechanism is operative. Further than this, if after an approaching train has slowed down in obedience to the speed-control indication, owing to a train being at the station platform, and had correctly proceeded past one or more of the "sentinels," the departure of the train occupying the station would clear all the "sentinels" subsequently encountered, and the moving train could steadily proceed.

The operation of the speed-control or time-governed mechanism of these "sentinel" signals is dependent upon the presence of a standing train at the station platform, or on the cross-over, and when the station track is empty, and the cross-overs free, the speed control does not operate. In this way the presence or absence of a train in the station track or on the cross-overs is the determining factor in the problem. The presence of such a train calls into play the protective mechanism, and the absence of such a train, by removing the necessity for station or cross-over track protection, automatically governs the "sentinel" signals and they indicate the line clear. The limiting point in the station express track is so arranged that the outgoing train has only to traverse about half the length of the station platform, *A* in Fig. 3, when the interlocking and the "sentinel" signals clear, and thus while a safe interval between the trains is automatically preserved, the time taken up in handling trains is reduced.

The record of the Subway shows that during the rush hours and before this mechanism was put in, 60 trains an hour on the south-bound tracks were operated with more or less detention to most of them. The present arrangement of speed control enables 66 trains to be moved within the hour and all on schedule time. A total south-bound train movement of 78 trains has been secured in the hour with the new system. In fact this approach signal system has increased the capacity of the station tracks at Ninety-sixth Street above that of the road above and below that point. In other words, it is possible to pass trains through the Ninety-sixth Street station faster than they can be handled in and out of other important points on the line. This system has now been applied to all the tracks at the Ninety-sixth Street junction.

The station and crossover tracks are, as it were, the nerve centers of the whole scheme, and the presence or absence of a train upon them determines whether the outlying "sentinel" signals shall give free entrance to the station or automatically hold down the speed of an approaching train and permit only what we have called its gradually slowing "conditional advance."

The successful working of this system has entirely removed the "choking" at the Ninety-sixth Street station as now applied to the various train movements. The new system removes the choking or congestion of traffic at this point, while securing safe and adequate train service. The officials of the Interborough Rapid Transit Company must be credited with a noteworthy achievement in the arts of signaling and of train operation.—Railway and Locomotive Engineering.

THE WHOLE WORLD'S HARVEST.

The Liverpool estimate of Broomhall on the whole world's wheat crop of 1909, perhaps the most important of the annual European calculations, is at hand this week. It shows the present year to have established an absolute high record in wheat output. The 3,346,968,000 bushels named as the world's total mean an increase of 9¼ per cent over the 3,063,280,000 of 1908. Compared with the 3,226,768,000 bushels of 1906, the previous record, the increase is 3⅝ per cent; compared with the year of scarcity, 1907, it is 15 per cent.

Two continents exceed all preceding records with their wheat production—North America and Europe. North America runs 17,000,000 bushels above 1901, which was the previous record. Europe's total runs 158,616,000 bushels beyond 1908, and surpasses the previous high record, that of 1906, by 21,160,000. Every important wheat-growing country of the world shows increase over the previous year except Austria-Hungary, Germany, and Spain. Russia's harvest runs 68,800,000 bushels beyond its previous high record. Canada's crop is 24,000,000 bushels above its best previous yield. The English harvest is the largest since 1899, and with that exception the largest since 1892; though it is highly interesting to observe that its 64,000,000-bushel yield of 1909, while making these encouraging comparisons, is still less than half the 140,000,000-bushel harvest of 1855, which has never since been equaled.

No such change in the world's grain trade from the two years of actual scarcity, 1907 and 1908, could occur without important results on commerce, finance, and industry. The wheat crop shortage of 1907, pretty much throughout the world, may have had some effect in aggravating the financial disturbances of that year. The failure of 1908 to replenish the empty storehouses—the whole world's "visible supply" of wheat, at the end of that year's harvest, was 14,000,000 bushels below even that of a year before—caused the past season's enormous shrinkage in the international grain trade, and also made possible the extortionate price to which wheat and flour were raised in last May's "Patten corner" at Chicago. It is a matter of interest, then, to inquire how far the financial situation generally will be benefited by the new turn in events.

The two immediate questions which arise are: first, what is the bearing of this harvest on the world's industrial prosperity; and, second, what is its bearing on our own export trade in grain? That return of abundant harvests, after scarcity, will be a help to better times, is a certainty. It is commonly said that the world-wide industrial activity of 1906 and 1905 had its origin largely in the world's bumper wheat crops of those years, and the inference is reasonable. It is also true, however, that the wheat yield does not settle everything. The world's bad wheat crop of 1889 was accompanied by an industrial "boom," and the two years of troubled markets, 1893 and 1884, broke all previous records in the harvests. This does not prove that good crops or bad crops had no effect at all, but it shows that the harvest's influence may be superseded by other economic forces. In the years referred to, it was the money market whose influence was paramount. Unbounded financial confidence and easy credit offset the bad world's harvest of 1889; derangement of money markets, due to abuse of capital and credit, offset the good harvest results of 1884 and 1893.

Our export trade in wheat will be influenced necessarily by the fact of bumper crops abroad. In so far as Europe raises enough to feed itself, it has less need to draw on the United States; and even in those European markets which must always buy foreign wheat, Russia and Canada are already competing actively with our exporters. This would apparently mean that wheat prices cannot continue high. The question of storehouses depleted as a result of two short crops just before 1909, is, however, also to be considered. The granaries of the world, on November 1st, held 30,000,000 bushels less of wheat than in 1906, but slightly more than in 1908 or 1907. What is more immediately interesting is that the stored-up supply in Europe's hands, though still some 12,000,000 bushels below November, 1906, is above all other years since 1904. In other words, a long forward step has already been taken toward restoring normal equilibrium between supply and demand.—Nation.

By reason of the superiority of yellow paint under the climatic conditions existing in Panama, the Isthmian Canal Commission have decided to paint the cars on the Panama Railway yellow. In coming to this decision the commission have followed the example set by some of the leading trunk lines in the United States which have made yellow the standard color for passenger equipment. Canary yellow has been adopted as the standard color for the coaches, refrigerator and box cars and all cars used in passenger service on the Panama Railway. Tests to ascertain the color best suited to withstand the local climatic conditions, which are unusually hard on exterior paints, were made, with the result that yellow demonstrated a superior lasting quality over the other colors that were tried.

ARCHITECTURAL ACOUSTICS.*

HOW SOUND INTERFERENCE IN BUILDINGS MAY BE CURED.

BY FLOYD R. WATSON, PH.D.

THE faulty acoustics of many of our buildings is called to the attention of the public at frequent intervals either by an account in the papers of the poor acoustics of some new structure, or else by attendance in an auditorium where difficulty is experienced in hearing easily. The question usually asked concerning such a case is as follows: "Cannot architects construct buildings so as to avoid these difficulties?" The purpose of this article is to give an account of the work that has been done in attacking the problem.

The most decided advance in the subject has been made by Prof. W. C. Sabine of Harvard University who published an account of his researches in the American Architect in 1900, and later a paper on the same subject in the Proceedings of the American Academy of Arts and Sciences in 1906. His work was on a practical basis from the start for the reason that he was called upon to propose a remedy for the acoustical difficulties presented in an auditorium just then completed at Harvard University.

In his analysis of the problem he states that three conditions are necessary for good hearing in any auditorium: the sound should be sufficiently loud; it should be free from resonance and interference, and spoken words should be clear and distinct.

These conditions are perhaps best understood by considering the case where a speaker addresses an audience. Sounds uttered by the speaker proceed in ever-widening spheres until they strike the walls of the room and are reflected back and forth, a little energy being absorbed at each reflection, until they finally die out. When it is considered that sound travels about eleven hundred feet a second, it is seen that a lecture room of ordinary size is almost immediately filled with sound because of the many rapid reflections in all directions. The first condition of loudness is thus obtained. The walls and ceiling reflect to the audience the sounds that would be lost if the speaker were in the open air.

While the reflection of sound has the advantage of fulfilling the conditions for loudness, it introduces at the same time certain disadvantages. Thus a reflected wave of sound in meeting an advancing wave may produce interference; that is, a reinforcement of the sound at some points and a comparative silence at others. It is a common experience in audience halls for an auditor to secure better hearing by moving his head to one side or the other; he simply moves his ear from a position of reinforcement or silence to a position free from interference.

Another disadvantage introduced by the reflection of sound is the possibility that the words of the speaker may be made indistinct. If the auditor is near the speaker, the sound comes to him first directly, then by reflection an instant later. If a time interval of more than one-tenth of a second elapses between the direct and reflected sounds, he hears an echo, and consequently has trouble in following the words of the speaker.

The reflection of sound may also cause a reverberation. As a sound wave is reflected from wall to wall, a small amount of energy is lost at each reflection and the sound finally dies out. If the walls are good reflectors, the sound may persist several seconds. In the meantime, the speaker has uttered other sounds and these mix with the preceding ones, thus causing a confusion that is called a reverberation.

The phenomena of resonance may be explained by considering first a mechanical example: a heavy iron ball suspended by a wire may be made to acquire a large swing by exerting a series of gentle pushes at the proper instants. So the sound waves, each one with small energy, act on a wall of the building at such intervals as to cause it to acquire considerable vibration, and thus reinforce the sound. An oak door one and one-half inches thick was found by the author to vibrate perceptibly when acted upon by a suitable sound. In an auditorium this resonance is a defect if the sound is reinforced too much.

The conditions that fix the acoustics of a hall are thus set down. The next step in the solution of the problem is to consider the changes that are possible in a room that has bad acoustical properties. Prof. Sabine assumed that only two variables exist in a room—shape including size, and materials including furnishings. As it is obviously impracticable to change the shape or size of a room without doing violence to the design of the architect, the only remaining means of cure is to change the materials or furnishings.

This latter change was the means used by Prof. Sabine in perfecting a method of cure. In an interesting set of experiments lasting over a period of four years, he finally evolved a law expressed as follows:

$$t = 0.164\,V \div a$$

where t is the time in seconds a sound will persist in a room after the source of sound is stopped, V is the volume of the room in cubic meters, and a is the absorbing power of the room—the unit of absorbing power being taken as one square meter of open window space.

An inspection of the relation shows that for good acoustical conditions, i. e., for a short time of duration of the sound, the volume of the room should be small and the absorbing power large. This confirms experience when it is considered that good acoustics are found in a small room with plenty of rugs, cushions and other absorbing material. If the volume of an auditorium is large, the only cure lies in increasing the absorbing power.

Prof. Sabine's method of taking measurements was to blow an organ pipe of five hundred and twelve vibrations a second in a room and record by a chronograph the time of duration of the sound after the organ pipe stopped. The absorbing power of the room was then increased by bringing in more absorbing material and the time of duration again measured. The effect of different materials was tested in this way. An open window was considered to be a perfect absorber of sound because no sound that passes out ever comes back. The absorbing powers of different materials were determined in terms of open window space. Thus the absorbing powers of one square meter of wood sheathing and one square meter of open window space are as 0.061 to 1.000.

Material.	Coefficient.
Wood sheathing (hard pine)	0.061
Plaster on wood lath	.034
Plaster on wire lath	.033
Plaster on tile	.025
Glass	.027
Brick set in Portland cement	.025
Audience	.96
Oil paintings (inclusive of frames)	.28
House plants, per cubic meter	.11
Carpet rugs	.20
Oriental rugs, extra heavy	.29
Cheese cloth	.019
Cretonne cloth	.15
Shelia curtains	.23
Hair felt, 2.5 cm. thick, 8 cm. from wall	.78
Cork, 2.5 cm. thick, loose on floor	.16
Linoleum, loose on floor	.12

Material.	Absorbing Power.
Audience, per person	0.44
Isolated man	.54
Isolated woman	.48
Plain ash settees, each	.039
Plain ash settees, per seat	.0077
Plain ash chairs, "bent wood"	.0082
Upholstered settees, hair and leather, each	1.10
Upholstered settees, per single seat	.28
Upholstered chairs, similar in style, each	.30
Hair cushions, per seat	.21
Elastic felt cushions, per seat	.20

With this table of absorbing powers at hand an architect can predict how long the sound will endure in a certain proposed building. It is only necessary to use the relation

$$t = 0.164\,V \div a$$

and insert the value of the volume of the building for V and the sum of the absorbing powers of the walls, woodwork, audience, etc., and the time of duration of the sound can be predicted before a brick of the building is laid.

It should be pointed out, however, that the method described in the preceding paragraph is true only for a sound whose pitch is five hundred and twelve vibrations a second. It would not be exactly true for sounds of different pitch; the error, however, would not be of special importance as will be shown presently.

Prof. Sabine, in a later investigation, showed that the duration of a sound depended on the pitch of a sound, and depended also on the amount of absorbing material present. As a concrete example, the high notes of a violin will be less reverberant with a full audience, than the lower notes of the bass viol, though they might have the same reverberation in the empty room. Again the voice of a man with notes of low pitch might give entirely satisfactory results in an auditorium, while the voice of a woman with higher-pitched notes would be unsatisfactory.

These considerations show that no hard and fast conditions can be attained for any special auditorium. The audience may be large or small, and the speaker's voice high or low. The best solution is a compromise where the average conditions are satisfied. Hence the solution as offered by Prof. Sabine is an average solution, and will doubtless be satisfactory in any ordinary lecture hall.

The problem of architectural acoustics has been attacked by other workers than Prof. Sabine. Prof. G. W. Stewart[1] proposed a cure for the poor acoustical properties of Sibley Auditorium at Cornell University. His experiments confirmed the work of Sabine.

Marage[2], after investigating six halls in Paris, confirmed the method given by Sabine.

Exner[3] investigated the acoustical properties of an audience hall, and gave details, analogous to those already expressed in this paper, for the conditions for good acoustics.

Jacques[4] investigated the effects of air currents on acoustical properties of buildings. He states that acoustics were good when a gentle, steady current of air passed through the room, and adds that acoustics were unsatisfactory when the current was haphazard.

Joseph Henry[5] wrote an excellent article on "Acoustics Applied to Public Buildings." His experiments and observations were made preparatory to designing an audience hall for the Smithsonian Institution.

The author is also engaged on the problem by investigating the properties of the Auditorium at the University of Illinois, which offers an opportunity to investigate both echoes and reverberations. This investigation is not yet completed.

In conclusion it should be pointed out that the action of sound in a closed hall is dependent on many factors, and that the complete analysis of the problem has not yet been made. There remains to be investigated the influence of temperature, air currents, the form of the walls of a room, the material of the walls especially as regards porosity. The development of the subject is important not only because of the advance from the standpoint of pure science, but also from the practical side in suggesting proper materials and construction so as to avoid acoustical horrors.

* The Technograph.

SUPERHEATED STEAM IN LOCOMOTIVE PRACTICE.

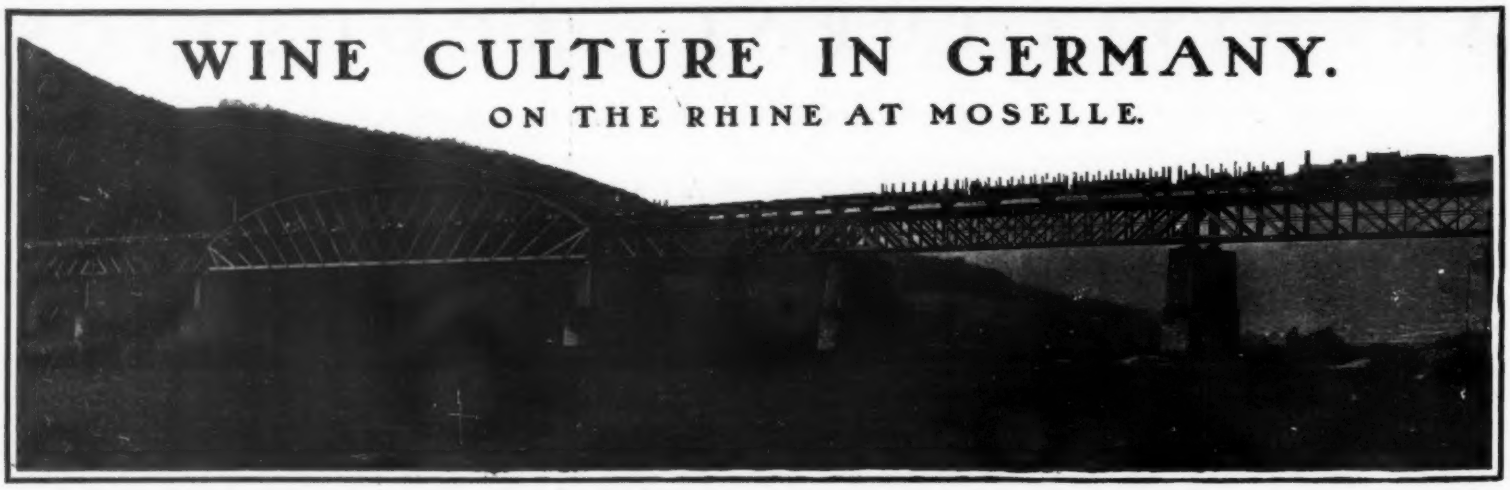
THE use of superheated steam in locomotive practice has now been more or less prevalent for five years and data as to superheater equipments with respect to reliability, ease of operation, and economy should be ready at hand. Last fall it was stated before the traveling engineers in convention that five hundred and ninety-four locomotives in the United States and Canada were equipped with superheaters. Investigation shows that fuel economy of from ten to twenty per cent is resulting from these superheater installations. However, there are so many other advantages to be taken into account that this economy falls into a back place. Generally speaking superheater engines are handling their trains more easily, more quickly and with a resultant increase in tonnage hauled.

There have been many difficulties in connection with the operation of superheater engines which have necessitated much and, in some cases, costly experimental work. For those who care to take advantage of the experience of others the road is open to immediate saving by the installation of one of the types of superheaters of which many have demonstrated their value. The principal difficulties and troubles encountered in the use of superheated steam occur with the piston rings and valve rings, smoke flues filling up with cinders and ashes, leaking of the large smoke flues at the fire-box end, splitting of superheater elements and leaking and failure of superheater connections. As proof that these difficulties have been overcome to a great extent, is the fact that shop men no longer present serious objections to superheater equipment. Backing up this statement is the expression from several motive power heads that superheaters have not increased the cost of locomotive upkeep per mile.—Railway Master Mechanic.

[1] Sibley Journal of Engineering, May, 1903.
[2] Compt. Rendus, Vol. 142, page 878, 1906.
[3] Zeitsch. des oesterreich Ingenieur und Architecten Verein, 1905.
[4] Phil. Mag. (5) Vol. 7, page 111, 1879.
[5] Smithsonian Report, 1856, page 221.

WINE CULTURE IN GERMANY.

ON THE RHINE AT MOSELLE.



ON the banks of the Rhine and Moselle, where wines bear a recognized trade name, each village has its own individual methods and processes, each developed by long experience and handed down from generation to generation.

Wine is obtained from grapes, the juice being extracted and collected in casks. In consequence of the increase of the yeast fungi already existing on the surface of the grapes, and therefore contained in the juice extracted, fermentation sets in, and under its action the sugar of the grape changes into alcohol and carbonic acid. A distinction is made between the primary and the after fermentation. In the former, the greater part of the sugar present is decomposed, with a more or less violent formation of carbonic acid; in the latter, the decomposition of the sugar remaining after the primary fermentation proceeds slowly, with a weaker development of carbonic acid; at the same time the wine gains in bouquet and flavor. After some months the wine is transferred to vats, where it still further matures, until it is ready for bottling. In the production of red wine, the skins and kernels of red grapes are allowed to take part in the fermentation. Under unfavorable weather conditions, sufficient sugar is not formed in the grape to produce a wine in which the acidity has been sufficiently overcome. If we wish to obtain under such circumstances wine rich in alcohol and less acid, sugar is added to the juice before fermentation. If the grapes, after the first extraction of juice, are allowed to ferment with sugar, we obtain a poorer wine, forming a favorite domestic beverage. From raisins and water is obtained a vinous beverage called raisin wine. These and many other products, which have nothing in common with wine but the name, are largely sold as pure wine. German wines contain 7 to 12 per cent of their weight in alcohol. Other wines contain 18 per cent and even more.

A particular kind of wine is sparkling wine or champagne, which was formerly manufactured exclusively in France, but is at present produced of excellent quality in the vineyards of Germany. In its manufacture, new wine, with added sugar, is allowed to ferment in flasks, the tight corking of which prevents the escape of the carbonic acid gas produced. The sweetness and flavor of the very finest champagnes are produced by the addition of liquor, generally sugar syrup with brandy and aromatic constituents, to the wine after it has undergone fermentation. Recently champagnes made by dissolving carbon dioxide under pressure in wine mixed with sugar syrup and liqueur have been put upon the market.

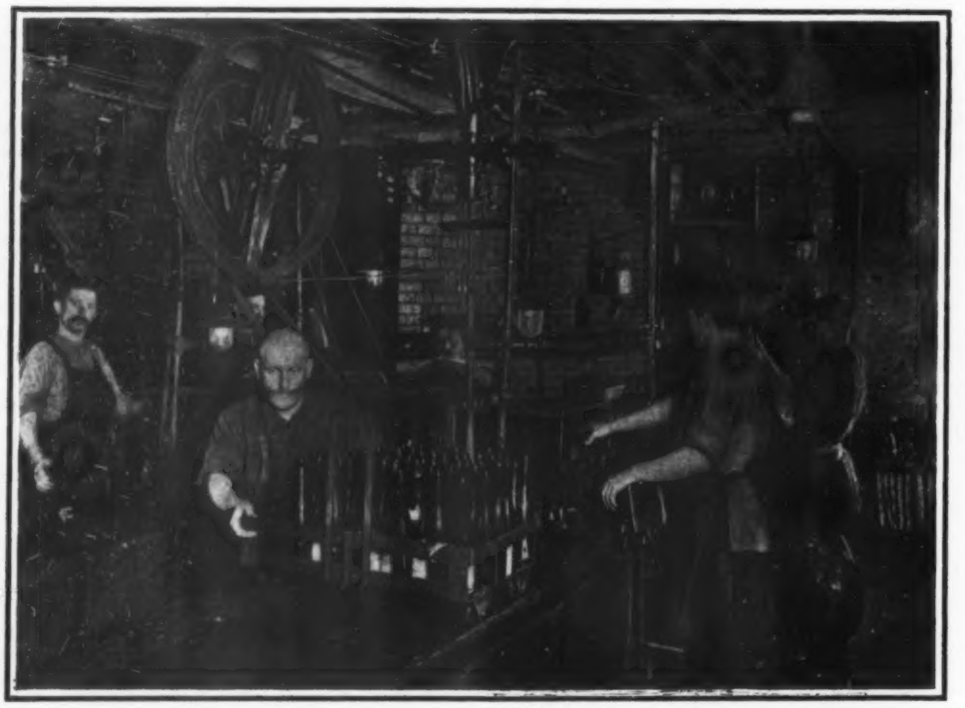
Wine culture in the Fatherland is of very great economic importance, in spite of the fact that only one 450th of the total area of the country is used for this purpose, and the further circumstance that it lies very near the northern limit of the growth of the vine. This is best seen by making a comparison with other wine-producing countries. Although from the standpoint of the area devoted to wine growing, Germany ranks no higher than tenth in the list, the money value of its output brings it nevertheless to the fourth place, on account of the remarkably excellent quality of the wines now produced in the valleys of the Rhine and Moselle in good years. Germany has been far more successful than other European wine-growing countries in combating the ravages of phylloxera, the method followed by Kempinski being one of extermination. Every vineyard is thoroughly inspected, and all vines found to be infected with phylloxera are destroyed, together with those in the immediate vicinity, the area thus disinfected not being cultivated for vines for several years. The primary object of this is to confine the evil to such narrow limits that wine cultivation can be afterward carried on in the old approved manner. This object has been accomplished.

The first appearance of the phylloxera scourge in the wine-growing districts was on the Ahr in 1881, and it was subsequently detected in the various wine regions of Prussia, Bavaria, Württemberg, Hesse, the Thüringian states, and Alsace-Lorraine. Thanks to the energetic measures taken, German vines have not suffered from phylloxera in recent years, but in spite of this favorable result, no efforts are being spared in testing all such methods, either of the culture or treatment of varieties of vine not subject to phylloxera, which can promote the future development of vine culture so that the drastic measure of extermination of vines need not be resorted to.

The chief wine districts of Germany are those in the western provinces, the principal ones being in the neighborhood of the Rhine and its tributaries. In the northern districts are hill and mountain slopes with southern exposures, which from the favorable conditions of their soil and climate are particularly adapted to the cultivation of the Riesling vine. It is believed that this variety originally grew as wild stock in the valley of the Rhine or of one of its tributaries. In addition to its other excellent qualities, it possesses a remarkably fine and characteristic "bouquet," and this too in spite of the various methods of cultivation. It has brought a world-wide fame to German wines, and is to be found at its very best only in the vintages of the chief wine-growing provinces of Germany. To the shaping hand of Nature has been added the intelligent observation of the cultivator, and the blending of these two factors has obtained the highest results.

The secret of the rare "bouquet" of German white wines is explained by some authorities by the fact that the Moselle wines come from grapes which are "moldy." The grapes grown in the Moselle valley are not subjected to sufficient heat to fill them with sugar, and are therefore allowed to be attacked by what is known as noble rot, in which process the mold fungus, having the habit of selecting certain crystals according to taste, picks out the acid first, and leaves just the proper proportion of sugar behind.

We are indebted to William Mayner, of the United States Consulate at Berlin, for the above facts and pictures relating to the establishment of Kempinski & Co. of Berlin, Rüddesheim, Nierstein, Laubenheim, Deidesheim, Berncastel, Valwig, Dusemond (Branneberg) and Cond (near Cochem).



ELECTRICALLY-OPERATED BOTTLE-WASHING MACHINES. DAILY CAPACITY, 15,000 BOTTLES.

WINE CULTURE IN GERMANY.

A WARSHIP SUNK BY A TORPEDO AS AN EXPERIMENT.

THE destructive power of a torpedo was strikingly illustrated by an experiment made last July in the Gulf of Spezia, by the Italian navy. An obsolete warship of 11,000 tons displacement, launched in 1885, was dismantled and altered for the purposes of the experiment at a cost of $80,000. It was intended to make three attacks, forward, aft, and amidships, and the vessel was anchored near short, so that it could be docked, examined, and repaired after each shot. The chief object of the experiment was to determine the number of water-tight bulkheads destroyed consecutively by the shot, and the effect of the shot on the flotation of the vessel. In order to test the effect on living creatures, five pigs were placed on board, near the point of attack.

But the first torpedo, striking the port bow, 13 feet below the water line, caused the vessel to heel to port and sank it so quickly that the examiners, who had come on board immediately after the shot, were compelled to flee for their lives. The experiment demonstrated the possibility of destroying a hostile warship by a single torpedo. The torpedo used in this experiment was charged with 264 pounds of guncotton.

The iron ores which have been mined in Cuba up to the present time consist largely of hematite and magnetite, and are obtained near Santiago, in the province of Oriente (Santiago). Recently large deposits of brown ore have been attracting considerable attention, especially those of the Mayari and Moa fields in Oriente Province and those of the Cubitas field in Camaguey province. Some 819,434 tons of iron ore were shipped from the mines in 1908, the United States taking 579,668 tons.

THE NEW SIMPLON LOCOMOTIVES.

POWERFUL ELECTRIC ENGINES FOR THE FAMOUS SWISS ROAD.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

IT is claimed that a distinct advance in the design of electric locomotives is secured in the most recent type which has been built for the Simplon tunnel section. The data concerning the new locomotives have been made public by the constructors, the Brown-Boveri firm, and we are able to give some of the leading points in order to show the advantages of the new design over the older locomotives. On the Simplon section there are now running two old and two of the new locomotives in order to handle the freight and passenger traffic.

The new locomotives are built for 1,700 horse-power, using as before two motors, while the old locomotives give but 1,100 horse-power. It was desired to give a high power to the new locomotives on account of the proposed extension of the electric line from Iselle, the present terminus on the Italian side of the tunnel, to Domo d'Ossola, and another reason for increasing the power lies in the fact that it requires an extra amount of 700 horse-power in order to run against the powerful air current which is given in the tunnel by the motor-driven blast fans.

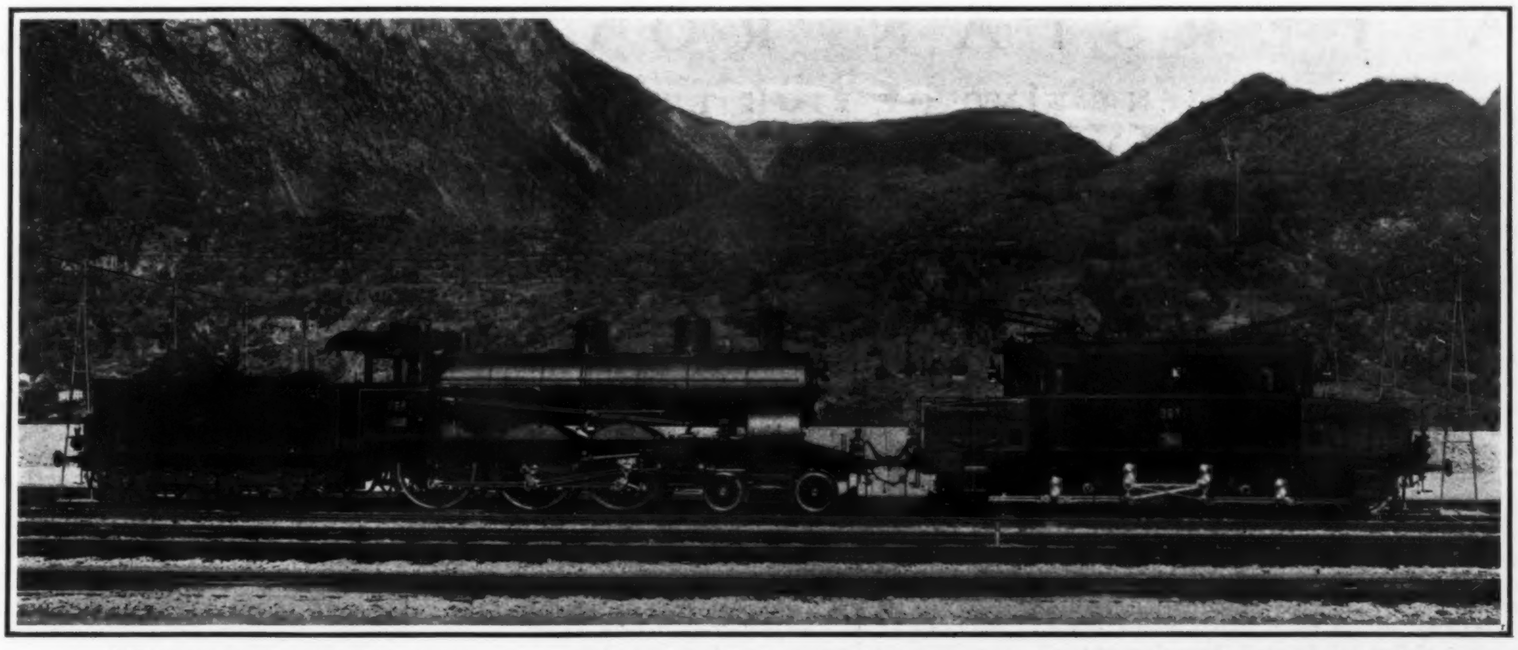
We will point out the main differences between the first locomotives, which are still running on the Simplon line, and the present ones. In the old locomotive there are used three driving wheels mounted at the middle part of the truck, besides a smaller rolling wheel at each end of the truck, making five wheels in all on a side. The two electric motors are mounted one on each side of the center of the truck and occupy a position between two of the driving wheels, the centers of the motors being placed higher than the wheel centers. Each motor carries a crank which is counterbalanced by a heavy sector-shaped weight, and a cross bar connects the two cranks of the motors. To the central part of this bar is attached a long driving bar which connects with the cranks on all three wheels, so that these last are driven from the two motors conjointly. A sliding bearing lies at the junction point of the motor bar and the wheel bar so as to allow the system to operate properly. One of the end driving axles and the next lying small axle are mounted together in a bogie, this being the case for each end of the locomotive, while the middle driving wheel is mounted in a separate bearing which is designed so as to allow a sliding movement for the axle.

For the new locomotive the driving method differs considerably from the former, as it was found better to drop the use of the small axles altogether and to use four driving wheels alone for the locomotive on each side. This gives the advantage of using the whole weight of the locomotive for adhesion, and we now have 17 (long) tons on each axle. In the former case the adhesion weight for axle did not exceed 15 tons, and the small axles carried 9 tons each which was not used for adhesion. This design spaces the two inner wheels at a considerable spread at the middle of the locomotive, and the two motors are now mounted side by side. A cross bar of X shape connects the two motor cranks across. From each end of this bar a long driving bar passes on each side so as to connect the cranks of the two driving wheels, such bars being pivoted to the ends of the motor bar and not as before connected at the center. As before, the motors lie above the center line of the wheels. We now have an equal distribution of weight upon each axle, which is an advantage. As there are no bogies now employed on the locomotive, some means must be used to allow them to take the curves of the track, which are 1,000 feet least radius on the main tracks and 500 feet radius on the side-tracks. This is done by the use of the Klien-Lindner system of sliding bearings in which the axle is mounted so that it can take the necessary movement in various directions such as are required for passing the curves. To aid in the movement upon the curves, the wheel diameter is cut down considerably from what it was before, this being 4 feet compared with 5 feet 6 inches. This brings the motors to a lower level, and the clearance above the track is now reduced to 7 inches. For the spread between the middle axles we have 15 feet 3 inches, and between the end axles it is 5 feet 8 inches.

Current is taken from the two overhead wires by means of a bow trolley designed by the Brown-Boveri firm. There is a similar trolley at each end of the locomotive. Two long arms of iron tube hold a cross arm at the end so as to allow for the swing of a pair of short bow pieces, one for each of the line wires. The bow pieces swing independent of each other by a spring and chain device. When on the road the small bows are put on the wires and they are held up in contact by springs. Should there not be enough pressure given at any time by the small bows, the springs of the base plate come into action so as to give pressure on the long arms of the trolley. For the part which takes the friction of the wire there is used a triangular section brass rod which presents one of its flat faces to the wire. It is turned about at times so as to use the other faces, and in this way there is given a very equal wear on the rubbing piece. Such a contact piece has been found to last for 2,000 or 3,000 miles running, and the cost is therefore quite low. On the other hand, the trolley wire shows but very little wear, this being found to be 1.5 per cent on the diameter during a two years' run. As all the framework of the trolley is grounded, it can be handled when on the road without any risk of danger from the high tension.

One of the points in which the new locomotive differs from the usual practice lies in the design and operating of the motors, and these may be said to be a new departure in the field of electric locomotives. What makes the motor radically different from the old one is the use of an armature of the short-circuited or "squirrel-cage type" in which there are used a set of heavy copper bars, these being all connected at the ends by copper strips. In the former motor the armature was wound with wire and had current brought to it in the usual way by a set of collector rings. For starting, there were used resistance strips placed in the armature circuit, so as to control the current. It is claimed that the new motor is much better to operate, as there is now no current brought from the outside into the armature, seeing that it acts entirely on the inductive principle which is peculiar to this kind of armature. We thus have a more solid construction and there are no electrical connections to look after as regards the armature proper, and no resistances to be replaced, as often happens. This is the first time that the squirrel-cage armature has been used on such heavy motors as we require here, but the designer of the present motors, Engineer Aichele, was able to overcome all the difficulties which had hindered the use of such motors for electric locomotives up to the present. Solidity is, however, only one of the advantages of the new motor, and another important one comes from the use of four different speeds which we are now able to secure. This lies in the fact that the squirrel-cage armature can be used independent of the number of poles in the field, which is not the case with a wire-wound armature, so that by changing the number of field poles we can have no less than four standard speeds, while in the old motor there were but two speeds available.

The field of the motor, which is shown here, is made up of a winding which is laid in grooves and is symmetrical, so that by simply changing the connections by switching we are able to vary the number of poles of the field. In the other motor two such changes were used, so as to give 6 and 12 poles for the motor. This gave two different running speeds of 21 and 42 miles an hour respectively for the locomotive. In designing the new motor it was found best to retain these two standard speeds so as to have uniformity with the other locomotives. At the same time there is added a second winding on the motor field which allows of producing 8 and 16 poles at will by the proper switching. This gives two other standard speeds of 16 and 32 miles an hour, and we have here the first instance of four speeds produced in a three-phase electric locomotive by changing the poles of the motor, and this appears to be quite a step in advance in such design. Now that two windings are used in the field, we have another advantage in the fact that the two windings can be used together when it is desired to give an extra effort in starting the motor, and the two are then thrown in parallel. This is found to be a great help in starting the locomotive on a heavy load,



1,700-HORSE-POWER ELECTRIC LOCOMOTIVE OF NEW BROWN-BOVERI TYPE COMPARED WITH STEAM LOCOMOTIVE OF ABOUT THE SAME POWER.

NEW LOCOMOTIVE FOR THE SIMPLON TUNNEL.

The line current is not used directly on the motors when at the starting. A transformer placed in the end of the locomotive reduces the tension for the motor, and the windings of the transformer give one main step of 1,000 volts and ten additional steps of 200 volts each, these being worked by a controller drum alongside the transformer, which the motorman operates by chain drive. By means of the voltage steps and the four pole-changes in the motor field we can effect the starting and running of trains are under the best conditions. The switching devices and the trolley have pneumatic control.

COOK VS. PEARY.

THE PSYCHOLOGY OF THE CONTROVERSY.

The expression of public sentiment encountered on every hand regarding the Cook-Peary controversy is not unique. Analogous discussions have disclosed a similar psychic condition at times throughout the world in the past. What the particular influence is that brings about this phase of mentality has not been discovered. That a wave of mental or psychic force sweeps over the world at certain periods in its history, however, must be conceded. It might be thought the result of sympathy brought about largely by criticism of one person of note by another of equal prominence, but this could hardly be so widespread or universal as to influence such large numbers in widely separated countries and of such divergent opinions in so short a time as has lately been manifest in the episode under discussion. An influence more subtle and far reaching must account for the people taking such a position and to their own thinking such unquestionable attitudes in the world's affairs as is shown in the present controversy of "Did Dr. Cook reach the Pole?"

The daily press, with the aid of the telegraph, exerts a powerful influence in forming public opinion, but, powerful as it is, it could not so quickly and effectively mold that opinion without the public being in a receptive frame of mind and already mentally conditioned to adopt suggestions. In this case it would seem that the usual order of events was reversed, as the press has followed the public rather than taken the lead, and what were the factors in this hastily-formed public opinion? Surely it was not due to a better acquaintance with one man than with the other. On the contrary, Mr. Peary has been in the public eye for years, while Dr. Cook was comparatively unknown. And it was not the result of personal contact with either, for both were a thousand miles or more away when the people of the civilized world arrived at a conclusion as to which was entitled to their confidence and allegiance. Was it that one man's poise, candor, and apparent honesty so impressed them that they declared their fealty? In other words, is the almost universal confidence confirmed in one by the lack of these elements in the other? There have been men in the history of the world who have commanded respect and confidence, while others equally brilliant have had the reputation of demagogues. Why?

It may be that there is a contagion of psychic phenomenon and, like epidemics of bodily disease, it may emanate from a single individual or focus. With no known means of staying it, it may sweep the world of intelligence. Insidiously, unknown to ourselves, we become infected, and, oblivious of the fact, spread the contagion to all with whom we come in contact. Witness the endemics, epidemics, which made possible the Christian Era, Mohammedanism, the Crusades, the holy wars of history, the dancing mania, Christian Science, etc. Purely psychic contagion. History is but a repetition of events under the guise of another name; some elevating, others degrading, dependent upon the mental phase of human nature at the time of infection. While we would not dignify the Cook-Peary controversy as epoch making or as one calculated to influence the morals or well being of man, or award it a place in the important events of the world, still the very great and worldwide interest in the subject of whether one or either ever reached the North Pole, and the feeling engendered in the merits of the rival claimants, are of more than passing interest.—New York Medical Journal.

A PERSIAN ROYAL TOMB.

RECENT FIND OF RICH TREASURE AT SUSA.

The tombs of the ancients were their richest treasure, and it is to them we turn for the records of the living past. The wonderful knowledge which we have gained of the life, manners, and customs of ancient Egypt has been almost entirely derived from the tombs of the Nile Valley. From the tombs of Mycenæ and Tyrins we learn much of the beginnings of Hellenic culture.

There are nations, however, who have denied us this chief source of information. Extensive as have been the explorations in Assyria and Babylonia, there has been nothing derived from the tombs, as no royal or other tombs of any importance have as yet been discovered. Our information, which has restored to us with such wonderful fullness of detail the life of the great Mesopotamian nations, has been derived from the ruined palaces and temples.

Another nation, of whom we know but little, has now revealed to us the resting places of her mighty dead, namely, that of ancient Persia under the Achæmenian kings. The exploration of the ruined palaces of the great Persian rulers, Darius, Xerxes, and Artaxerxes, at Susa and Persepolis, have given us a wonderful knowledge of Persian art and an insight into the court life and religious ceremonial of these mighty opponents of the rulers of Babylon and Greece, but of the life of the Persians we know but little, says W. St. Chad Boscawen in the London Globe, and that little is chiefly derived from external sources. Flavius Arrian, the chronicler of Alexander the Great, has preserved for us a description of the great tomb of Cyrus—at Persagidæ—which Alexander visited and restored, and its magnificent and barbaric splendor befits the resting place of so great a monarch.

Many commentators have regarded the description given by the Greek writer as overdrawn, but like many other doubtful passages its veracity has been established by archæological discoveries. The Greek writer tells us that the tomb of Cyrus was placed in a beautiful, well-watered garden at the royal garden city of Persagidæ, near Persepolis. The description he gives of the edifice is now of the greatest interest. It was of moderate size, of square form, and raised on a solid square stone plinth. It had an arched roof and the entrance was so narrow that only a very slender man could enter. Within it was the golden coffin of the King resting on a funeral couch of gold, the legs of which were very massive and richly wrought.

In the golden coffin lay the body of Cyrus clad in his royal robe of purple, products of the finest looms of Babylon—his trousers being of the Median style. He had a gold chain round his neck, bracelets on his arms and earrings in his ears, and these together with his golden sword were all adorned with precious stones. The Greek description does not seem very clear—but it would appear that there was no lid to the coffin, it being covered with rich embroideries and resting on a heavy pile carpet.

The description of Arrian has lacked any confirmation until now when an important discovery shows its accuracy in the main details. Some minor excavations on the south of the citadel mound at Susa resulted in the discovery of a small square building decorated with enameled bricks—and evidently a small chapel or temple of the Mazdean rite. South of this is a heap of *débris* of some fallen building with a number of enameled bricks also. In this heap was found a large bronze vessel of bath form turned partly on its side.

The rubbish being cleared away the object was found to be a fine coffin of the best bronze, measuring about five and a half feet in length and about three feet wide. There was no trace of a cover, the coffin being open. Inside was a human skeleton in good preservation, and what was more astonishing several objects of precious metal. The first of these was a fine silver cup of rich design, which lay on the left side of the body. It was a fine work of art in the best Assyrian style, resembling especially the bowl the Queen of Assurbanipal holds in her hand in the sculptures of the Garden scene, in the British Museum. It was fluted and the bottom decorated with an open rose pattern and weighed about 589 grammes.

A more careful examination of the contents revealed a rich treasury of Achamenian jewelry such as had never before rewarded the explorers of Persian sites. The jewelry all lay on the body as worn by the deceased in life. Round the neck was a gold torque of fine workmanship. It was decorated with gold bead work, encrusted to resemble thread or cord, and the terminals of the clasp were two beautifully modeled lions' heads. These heads are in most finished style, and are inlaid with turquoise eyes and lapis lazuli plaques, while collars of lapis lazuli and raised gold work divide them from the main portion of the torque.

Forming part of the same set were two bracelets circling the wrists—also of solid gold, also with lion head terminals. The style was similar to that of the torques and bracelets of the Assyrian kings Assurnazerpal (B. C. 885), found at Nimroud. This set was remarkably like the fine gold ornaments—the so-called Scythian treasure—found in Afghanistan, now in the British Museum. This set of barbaric ornaments would alone have been a rich find, but there were many more objects of great value and artistic beauty in the coffin. Round the neck and resting on the breast was a beautiful necklace of beads in four rows. The beads were long olive shaped, of amethyst, jasper (green and red), lapis lazuli, emeralds, agate, and red and white coral, separated from each other by small gold cushion beads of great beauty and finish.

At regular intervals were small pendants of curious shape like an unopened bud of a flower encrusted with jewels. The gold clasps were of rose form set with turquois and lapis lazuli. The whole formed a beautiful piece of the jeweler's art, but somewhat bizarre in style. One other object is worthy of special notice, as it is almost unique, namely, a fine collar of five rows of the finest Oriental pearls—no doubt from the Persian Gulf—about two hundred in all, the collar being divided into sections, as it is of the form now known as the "dog collar shape," by bands of gold studded with turquoise. This ensemble is very fine and it must have been a very precious treasure indeed, worthy of a royal wearer. Near to the necklace were some beautifully finished gold charms, a lion, and a ram-headed sphinx.

There were a number of small articles in the coffin, which although precious as works of art are still more important as throwing light upon the questions of mode of burial and probable date. At intervals were found richly decorated gold buttons and a brooch such as was used to fasten a robe, and in the bottom of the coffin was found a quantity of fluff and dust of some very fine textile resembling byssus, or "the royal cloth" of Egypt, which was much prized by the Persians. The body when interred had been clothed as was Cyrus.

The question of date is still a little obscure. In the coffin were found two alabastron vases resembling those often found in Persia and Egypt, and usually inscribed with the name of Artaxerxes II. These examples, however, were not inscribed, so did not help us. There were found some small silver coins, which had been struck at Arvad, and bore the image of the Satrap Melgart (B. C. 350-332), who issued coins from both Ardus and Tyre. On these grounds the burial may be safely assigned to the latter end of the reign of Artaxerxes II.

The find is most important as throwing light upon the early Mazdean burial customs and on the accuracy of the statements of Arrian. The law of the Avesta prohibited both earth burial and cremation, the sole method being that of exposure in the open air, or in the "Towers of Silence." The contact with the earth was avoided by the use of a metal coffin and exposure was obtained by having no lid to the coffin, but rich embroideries. Arrian tells us that near the tomb of Cyrus was a small temple where two magi dwelt who tended the tomb. The small square temple at Susa may have been for a similar purpose.

Alexander closed up the door of the tomb of Cyrus and sealed it. Something similar must have been done to this tomb, otherwise the treasure would not have escaped the hands of the spoiler. As to the identity of the occupant there is no clue, but the wealth of the jewels and the richness of the burial justify us in regarding it, if not as a king's tomb, as being one of some member of the royal family or a rich Persian official. There is just a presumption that the body is that of a female, but as the men in ancient Persia wore much jewelry, as shown by the Persepolis sculptures, this may not be certain. However, the find is one of the greatest importance to Oriental archæology.

ACTION AT A DISTANCE.

PHOTOGRAPHIC EFFECTS OF DRYING OILS.

BY WERNER SCHMIDT.

THE discovery of radioactive substances naturally caused many to turn to the examination of all kinds of materials, with a view to investigating whether they by any chance exerted an action at a distance resembling radioactivity. At the present day there is ample material to show that radium does not stand alone with its emanations, but that many other metals also, and various substances, produce effects at a distance and have a more or less pronounced action upon a photographic plate.

In such cases, however, we are not by any means necessarily dealing with radioactive processes. For the term radioactivity implies something more than the mere property of sending out invisible rays which affect the photographic plate. Radioactivity is characterized by certain other typical effects. Thus a charged electroscope is discharged if a radioactive body is brought near to it; the rays proceeding from radium can be deflected by a magnet; colorless salts and gems acquire a more or less marked and permanent coloration by exposure to radium, and so forth. All these typical effects are produced exclusively by the elements of the radium group, such as thorium, actinium, polonium, uranium, etc.

However, quite a large number of other substances, which do not display these characteristic radioactive effects, nevertheless do possess the faculty (which first attracted attention in the case of radium) of affecting the photographic plate, in other words, of producing an action at a distance, as if by invisible radiation. Among these substances is the class of so-called "drying oils," i. e., oils which in contact with air undergo oxidation, and harden to a solid mass. The best known example of this kind is linseed-oil varnish.

The occasion for the investigation of the phenomena here concerned arose out of certain observations made in the paper industry. It had been noticed that mucilage (gum arabic), as used in the manufacture of letter-envelopes, under certain conditions passes into an insoluble state. On moistening the gummed edge of such envelopes, in which the change in question has taken place, it is observed that the gum absorbs the water like a sponge. The surface looks lumpy and rough, and has an appearance like starch flour. The adhesive power is completely lost, and from its original colorless state the gum has turned brownish yellow.

Now it was a remarkable fact, that the gum had deteriorated only on envelopes whose inside or outside was covered with a printed or lithographed pattern, such as is frequently used in order to render them opaque. This peculiar influence of the printed surface showed even where there was no visible connection between the gum and the print.

Since the same effect was observed without exception, no matter what coloring matter had been used in the printing process, the cause of the change could reside only in the binding agent common to all printing inks. This binding agent is in all cases linseed-oil varnish.

The alteration of gum proceeds only very slowly, and it was therefore desirable, for the purpose of the investigation of the phenomena involved, to work with more sensitive material, namely, photographic plates. Dry plates were covered with different samples of printed papers or with glass plates coated with linseed-oil varnish and allowed to dry. Various objects such as paper, glass, small pieces of metal, coins, etc., were interposed between the photographic plate and the varnish, in order to obtain, if possible, "shadow" effects, which would give a clue as to the character of the forces emanating from the print. At the same time this would show whether some bodies were transparent to the "radiation."

After eight to ten days exposure the plates upon development showed very clear shadow photographs. Metal, glass and mica showed up with sharp edges. However, coarse wrapping paper one-fifth of a millimeter thick gave a rather less marked shadow, and fine (so-called grease-proof) cellulose paper one-fifteenth of a millimeter in thickness was clearly traversed by the radiation. Direct copies are also obtained of words printed with ordinary coloring matter upon the paper, and this action takes place through the paper, for if the latter is placed with the unprinted side against the plate, a copy is nevertheless produced.

In order to investigate further the mode of propagation of this effect, experiments were made with the following arrangement: At the bottom of a small cardboard box was laid a photographic plate, and upon it a narrow vulcanite frame about two millimeters thick. This latter served to support a brass plate provided at the center with a hole one millimeter in diameter. Over this, and separated therefrom by a second vulcanite frame, was placed a glass plate coated with linseed-oil varnish (see Fig. 1). This box with its contents was allowed to stand for three weeks at room temperature. The plate was then developed, and showed the image of a ring, as seen in Fig. 2. Another brass diaphragm, with a slit one millimeter broad and two centimeters long, gave, under similar conditions,

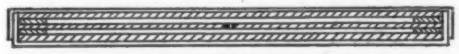


FIG. 1.

an elliptical ring (Fig. 3). This ring formation caused considerable surprise, until the matter was elucidated by further experiments. Advantage was taken of the observation which had been made, that the radiation from the varnish increased with rise of temperature. Eight photographic plates were therefore exposed in the manner described above, but at a temperature of 40 to 45 deg. C. (104 to 113 deg. F.). Every two hours one plate was taken out, and thus the process of formation of the ring could be followed step by step. It was found that there first formed on the plate a dark spot, which gradually spread and became larger. Finally this spot acquired a bright nucleus, so that a ring was formed. If the action was allowed to continue for a sufficient length of time, the image ultimately was completely reversed, so that the plate showed, instead of a black shadow, a bright image on dark background.

Thus the action of the varnish is exactly similar to

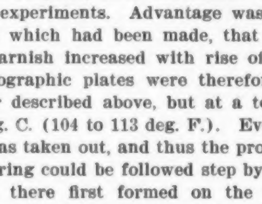


FIG. 2.

that of light, which, as is well known, will produce a reversed (positive) image on sufficiently prolonged exposure. This phenomenon is known in photography as solarization, and it is interesting to note that this solarization is produced also by the action of varnish.

The next step in the investigation was to examine the penetrating power of the "radiation." Pieces of foil of various materials were inserted into the exposure box under the perforated brass plate. Substances thus examined were glass, mica, gold leaf, celluloid (¼ millimeter thick), paper (0.05 millimeter thick), gutta percha (1/5 millimeter thick), and gelatine (¼ millimeter thick). The result was rather surprising. Glass and mica, as might have been expected, were quite opaque, but all the other materials tried were pervious to the radiation, and some of them, as celluloid, gelatine, and paper, in very high degree.

This peculiar action at a distance produced by the varnish can also be shown on polished metal plates.

FIG. 3.

These usually become blackened in the neighborhood of printed surfaces. Thus if a fairly recently printed paper is packed up together with a bright zinc plate, and exposed for several days or weeks to a moderate heat, an image of the printed characters or drawing is found to have formed as a dark stain of oxides upon the bright background.

The explanation of these phenomena is probably to be sought in the property which the varnish possesses, of giving rise to ozone or other peroxide bodies in the course of its "setting," i. e., oxidation. These products form traces of hydrogen peroxide in the presence of moisture, and it is probably the hydrogen peroxide so formed which causes all the observed effects. This substance exerts an oxidizing and bleaching action upon organic matter in its neighborhood. Thus for instance the cork stopper of a bottle containing varnish in a short time becomes bleached. The penetration of colloidal bodies by this action is quite what might be expected, for they are mostly capable of taking up hydrogen peroxide, and allowing it to evaporate off on the opposite side.

In this way the action of the varnish upon the photographic plate can be quite satisfactorily explained. At the same time these observations give the clue to the behavior of gum arabic in the presence of linseed-oil varnish.

When this influence upon gum arabic was investigated it was found that the purity of the solutions used for preparing the gummed surface was an important factor. Certain metallic impurities in the water used, or in the gum itself, may materially influence the process which goes on. But the alteration of the gum arabic could be demonstrated in all cases, if only it was left for a sufficient length of time in the neighborhood of printed paper or a varnished surface.

Here again there was a remarkable parallelism in the action of the varnish and that of light. It was found that exposure to sunlight caused the same change in the gum arabic, and that the time required for the alteration was almost identical in the two cases. Thus if a surface coated with gum containing iron salts as an impurity is laid in the sun, it loses its adhesive power in a few days, even though the impurities present amount to less than one in one thousand; the same is the case if the gum has been exposed to the action of a varnished surface. If on the other hand gummed paper is stored by itself in the dark, the gum seems to keep indefinitely. Some of the experimental results obtained are tabulated below.

Substances Added to a 23° Bé. Solution of Gum Arabic.	The Coat of Gum Became Insoluble		Remained Unchanged in the Dark on Storing in Absence of Varnish.
	By Exposure to Light.	By Action of Varnish in the Dark.	
Pure gum solution without addition........	In about 90 days.	In about 90 days	After 365 days.
Ferrous sulphate, 1 : 1000.......	In about 20 days.	In about 15 days.	After 365 days.
Iron dissolved by galvanic action, 1 — 2 : 1000	In about 25 days.	In about 25 days.	After 365 days.
Potassium bichromate, 1 — 2 : 1000	Very quickly.	In about 8 days.	After 365 days.

From the experiments it was therefore evident that gum arabic behaves more or less closely like a dry plate according to its composition and the degree of its purity, and that the proximity of drying varnish has an action upon gum similar to that of light.

Radioactive substances are not capable of causing this alteration in the gum, and in other respects also the action of varnishes differs entirely from radioactivity. On the other hand, the experiments described above show that in the neighborhood of drying oils an action occurs which outwardly resembles certain kinds of radiation, in affecting the photographic plate, and producing this effect even through interposed shields of colloid substances, such as paper, gutta percha, gelatine, celluloid, etc.—Abstracted from Zeit. fuer physik. Chemie.

In their latest published patent Messrs. Orville and Wilbur Wright disclose a method of automatically controlling and maintaining the balance of the machine longitudinally, laterally, and vertically. The method consists in employing a movable horizontally mounted plane adapted to be actuated by air currents. This plane is mounted on parallel levers just in front of the main planes and between the main planes and the elevator plane. The automatically operating plane is rigidly connected to a link pivotally jointed to the front ends of the projecting levers. The rear end of one of the levers is provided with a weight to balance the movable plane. Air currents met with that tend to upset the balance of the machine automatically deflect this plane. By means of the plane a valve is operated between a differential cylinder containing a differential piston and a reservoir in which air is stored under pressure. The movement of the differential piston in its cylinder by means of the air pressure is employed to control the elevator plane, the warping planes, and the rudder, so as to counteract any tendency of the wind to disturb the balance of the machine as soon as it occurs. Means are provided to enable the pilot to control and vary the automatically operating mechanism during flight.

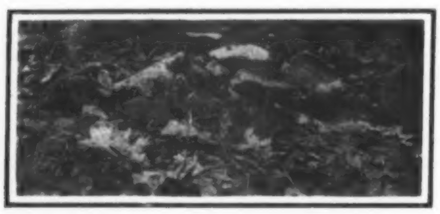
SOME OF THE SHOWY MUSHROOMS IN NATURE.

THE BOLETUS FAMILY.

BY WILLIAM HOSEA BALLOU.

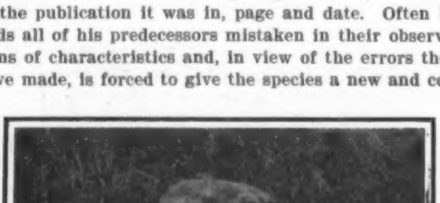
THE nomenclature of the Boletus family, or tube-bearing fungi, has just had a thorough revision at the New York Botanical Garden, by Dr. William Alphonso Murrill, Assistant Director. This fact enabled me to prosecute the photography of forms growing in life in New York city and vicinity, with the certainty of absolute identification of species and correct labels for negatives. Every species has innumerable variations in external appearances, due, I conclude, to different food supplies drawn from different soils. These variations make differences in colors and shapes. But whatever the variations, the spore of each species usually remains the same, and when placed under the microscope, reveals the correct name. Herein we have the great confusion of names caused by collections in museums, more or less imperfectly dried or distorted by insects. Imperfectly dried specimens can seldom present correct features for identification, particularly in cases of wide variation from the normal. All of the specimens I photographed growing in life were immediately placed living in the hands of Dr. Murrill, so that there could be no doubt as to their identity. The specimens were then scientifically dried and filed in the museum, adding to those already in stock there, and aiding to show the entire correct range of variations.

The variations in color and shape of the members



ROSTKOVITES GRANULATUS.

of the Boleti family are responsible for many errors by botanists in the past. The most extraordinary mistakes were those by botanists unable to distinguish Boleti features and placing them in some of the other families, mostly the Agarics, but some of them even in the Polyporaceæ. In revising nomenclature, modern methods are now applied in every department of natural science as pioneered, I believe, by the late Prof. Edward Drinker Cope. Cope first noted that the characteristics of the skull determined accurately most species of mammal and bird life, and the reproductive organs in reptile life. In revising nomenclature, a specialist seeks to borrow from museums and collectors all of the specimens referred to a given family. Having these before him, he exhaustively examines all of the literature ever printed on the family in question. He then separates the specimens into each genus to which they belong, and these into each species. He then takes all the specimens of a given species and makes a list of all the various scientific names that have been given it. From the literature in hand, he awards to each species the name given to it first, crediting the specialist who first named it. That is why, when you see a description of a species, it is preceded by a list of all the scientific names given to it, the name of the scientist giving each one, the name of the publication it was in, page and date. Often he finds all of his predecessors mistaken in their observations of characteristics and, in view of the errors they have made, is forced to give the species a new and cor-



CERIOMYCES MINIATO OLIVACEOUS.

rected description and a new and more appropriate Latin or Greek name.

Certain Boleti are still coming up at the date of this writing, October 20th, and will continue to do so until very cold weather. In fact, this is the season when the most showy forms of many fungi are likely to be found in gorgeous array. So far, I have photographed 22 species of the Boleti, out of perhaps 150 species known to America, of which one was new to science. Of these, the showy species will be figured herein as I saw them in the field. The variations were often most puzzling to me, causing me, in at least one instance, to pass by the most gorgeous and largest specimen of a species (*Gyroporus castaneus*), of

CERIOMYCES PALLIDUS.

which I had photographed only smaller specimens. However, I have the date and locality and next year will try to find a duplicate. Worse than that, on the same day and on the same forest roadway, in a space of 300 feet, I picked up without photographing, and placed in the collecting basket, seven species of boleti, which, because of their small size, and without examination, I considered merely young forms of specimens already in stock. Among them was the species new to science and which had just been discovered and named *Ceriomyces Morrisii*, by Peck. The smaller species would necessarily form a separate article. Following are some of the showy forms photographed in nature, with their new names, after Murrill, as recorded in his memoir on the Boletaceæ, published recently in the new magazine, *Mycologia*, and his new monograph on the family just issuing from the press.

YELLOW TUBE MUSHROOM (*Ceriomyces bicolor*).—Edible. Not many have collected this species. I found it in a cow pasture containing one small oak under which it grew. It has a purplish red cap, or top. The base, or hymenium, is bright yellow and smooth, like ointment packed in a tin box. The stem is yellowish, but usually with red streaks. In drying, the base turns brownish, and but for the red streaks on the stem, might be taken for another species. I found many brown-based specimens elsewhere, showing that

CERIOMYCES RETIPES.

they were passing into old age, which captures most fleshy fungi within a week from birth. A single woodland presents a constant panorama of passing species of fleshy fungi. Unless thoroughly examined every week from earliest spring to latest autumn, hundreds of species may escape observation. Many species come up to-day and are gone within the week, not to be seen again for a year. Every woodland, also, seems to present a different set of species at a given time, seldom duplicating each other. A single collector, therefore, would necessarily be omnipresent over the entire world to gather all the species appearing simultaneously. Again, there are innumerable species coming up during the entire nine months at all times, some of them on precisely the same spot. A rare puff ball, *Bovistella Ohioensis*, has been fruiting since the earliest spring on a small patch of the border of the New York Botanical Garden.

BITTER TUBE MUSHROOM (*Tylopilus felleus*).—Poisonous. Cap smooth and light brown, pink sheen on base when turned back and forth, making certain identification. I photographed the first specimen June 17th, pendent from an overturned root, west of Allenhurst, N. J. Thereafter I found specimens everywhere in Monmouth County woods. The largest specimens measuring up to 7 inches in diameter I found in the great Allaire woods growing along an entire hillside. September 21st was the last date any were observed this year. Murrill records it as growing over a foot in diameter.

SLIMY TUBE MUSHROOM (*Rostkovites granulatus*).—Edible. The cap is convex, the base flat. The whole boletus is yellow in youth; every young specimen I have seen, usually growing in large groups, had yellow caps, hymeniums and stems. As they age, the cap turns reddish brown. In meadows the stems are short, in forests they are more lengthy. In meadows the caps are broad and rather thin, in forests often chunked. In one group, I counted many shapes, but all golden yellow. They may be found from summer to late aututmn.

GREEN TUBE MUSHROOM (*Suillellus luridus*).—Poison. Cap brownish, base red or reddish, changing to brown when dead. The tubes are yellowish with red mouths. If cut, the entire surface of the boletus turns blue or salmon colored. The stem is yellowish. Usually upon its decay it is attacked by a slime mold, as are many species of the boleti. If found at the right age this is one of the most showy and most gorgeous of species, with its rich red hymenium. One can forgive it being poison, it is so beautiful, and to me the beauty of the fungi generally appeals far more than all of their edible, destructive or other characteristics. The largest group of *luridus* I found was growing closely bunched under an oak tree on the lawn of the Botanical Garden. It looked like a collection of kaffir huts with the roofs overlapping. The adjoining oak tree was entirely monopolized by the black and white spe-

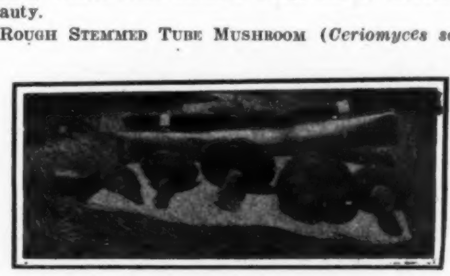
TYLOPILUS FELLEUS.

cies *Tylopilus alboater*, the only specimens that have been found in this section. I found one specimen of *luridus*, growing on a large vine of poison ivy, two feet above the base of the tree entwined, demonstrating that one poisonous plant can exist on another poisonous plant, the poisons neutralizing each other.

BRIGHT YELLOW TUBE MUSHROOM (*Ceriomyces miniato olivaceous*).—Poison. This is a generally yellowish species, with large stems. The yellow of the base, however, is very bright and looks like ointment packed in a box. It also quickly changes to blue when cut or bruised. Under an oak on the lawn, not far from the last two species, this type came up at intervals all last summer. I have not yet seen it growing elsewhere, although its range is from New England to West Virginia.

RETICULATED MUSHROOM (*Ceriomyces retipes*).—Edible. All golden yellow, so far as I have seen, but its cap is said to vary to brown, perhaps from aging. The only group I met of this species was in the big Allaire, N. J., forest, owned by Mr. Arthur Brisbane, editor of the New York Evening Journal, under a thinned-out clump of pine trees. None appeared again after collecting those visible in the latter part of August. The stems were large and long, finely reticulated (having a network), the whole boletus firm with caps varying up to 5 inches wide. The specimens were readily visible some distance away, and of exceeding beauty.

ROUGH STEMMED TUBE MUSHROOM (*Ceriomyces scaber*).—Edible. Various hues above, roseate, lavender, dark and light, but all white below. A very firm species with diameters up to 8 inches and weights up to 4 pounds. I have found it common in the piny woods everywhere, although not confined to them, from early spring to latest autumn. The caps are very round, convex, and thick. Enough of them go to waste to feed a large population. It is easily distinguished



SUILLELLUS LURIDUS.

by its scabrous stem and white hymenium, although its many colored caps often deceived me for some time until I grew familiar with its vagaries.

LARGE-TUBE MUSHROOM (*Ceriomyces edulis*).—Edible. All yellow or shades of it, up to 8 inches in diameter, the skin of cap often cracking. In age it usually dries out as if tanned. The first forms I met were snowy white from an attacking parasitical mold. Thereafter I found many normal specimens under

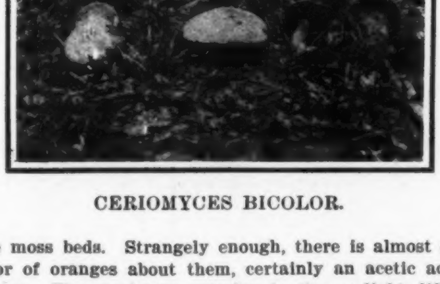
CERIOMYCES EDULIS.

spruce and pine trees. The first group had been attacked by a mold as soon as they commenced growing, because the mycelium was imbedded in a rotten stump where the parasite was entrenched. Two specimens I found growing in a large group of the deadly *Amanita muscaria*, both species all the same color, under a spruce tree.

TULIP-SHAPED BOLETUS (*Boletinellus merulioides*).—Cap brown, base yellow with a network of little squares. I first came across a large group, or series of groups of this mushroom, under a huge, spreading ash tree in the Shetland pony pasture at Allaire, N. J. At first sight it seemed as if one had entered a field of dark brown tulips, as every specimen was curled up tulip shaped. Some children, playing near by, asked me what kind of flowers they were and refused indignantly my explanation that they were fruit and not flowers. The next group discovered was in a dark, narrow, covered flume, not far away, where none of them was tulip shaped, but flat on top. The flume was made to confine a small creek, emptying into Manasquan River. By removing a plank overhead I got light enough to photograph the specimen, the largest and most gorgeously colored I have seen. The species identifies itself by its network of little squares on the yellow hymenium.

ALL-RED BOLETUS (*Suillellus frostii*).—All red, with smooth red cap, red base, and red stem, named for the lamented C. C. Frost, a pioneer specialist on the Boleti, who forgot to name any of his discoveries, new to science, after himself. I first saw a group of blood-red specimens shining in a brush and log heap in a clearing of the Allaire, N. J., forest. There was no way to clear the ground and photograph the group, so I awaited discovery of more kindly-inclined specimens, which came later at Allenhurst, N. J. On a high hill, also in the Allaire forest, I saw an entire moss bed dotted with small specimens, their smooth red caps shining in the brown moss. This species also identifies itself by the characters mentioned. It is common enough in New Jersey, but only grows large where it has plenty of sunlight. I saw no specimen, however, over 3 inches in diameter.

THE ORANGE BOLETUS (*Boletus subsanguineus*).—One form has an orange cap, whitish orange base and stem. Another form is all brown, dark brown cap, light brown hymenium and stem. The third form is a blending of orange and brown. I photographed all three forms growing in moss beds in a grove at Deal Beach, N. J. The caps averaged 1 to 2½ inches in diameter, but at Allaire I got a snap at a cluster of specimens out in the open, the largest of which was 5½ inches across. My first glimpse at the clusters in the Deal grove led me to pass along, as I thought some picnickers had thrown a lot of orange peels in



CERIOMYCES BICOLOR.

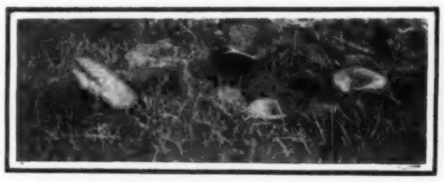
the moss beds. Strangely enough, there is almost an odor of oranges about them, certainly an acetic acid aroma. The specimens growing in the sunlight differ in color, having light orange caps, white hymeniums and stems, and might be mistaken for *scaber*, except that the stem is not scabrous.

PALLID MUSHROOM (*Ceriomyces pallidus*).—Buff cap and greenish base. This is a common variety, growing very large at times, especially in the finely pulverized soil of a burnt and blackened forest. In the Deal Lake woods, New Jersey, specimens grew 6 inches across in such soil and conditions. Its pallid cap, usually spotted as if rain drops had marred it, identifies it at once. Some specimens, however, have quite brown caps with dark brown rims around the edge and do not look at all so sickly and dissipated as the generality of the type.

The Boletus family is a lover of oak trees, and in summer one is pretty sure to find a species of some kind under the afternoon shady side of any oak, anywhere, in field or forest.

FORKS AND CLEANLINESS.

DOMENICO SILVIO, doge of Venice from 1054 to 1096, is less known to fame than his wife, a Greek princess, whose peculiar habits made her an object of scandal and fear. The unfortunate woman had brought with her a small two-pronged gold fork which she used to convey food from her plate to her mouth. This innovation seemed so unnecessary and absurd a refinement that a general cry of indignation and horror arose, and the priests publicly invoked the chastisement of heaven upon the unnatural creature who refused to eat with her fingers. She soon died of a mysterious disease and all Venice regarded her taking off as a punishment for her sins. This awful example of Divine wrath



BOLETINELLUS MERULIOIDES.

formed the theme of sermons during three centuries, and more than four centuries elapsed before a fork again appeared on a Venetian table. About the year 1500 a few sybarites ventured to introduce the accursed implement and the Venetians gradually became accustomed to it. An English traveler, Thomas Coryate, endeavored to introduce the use of the fork into England, but he was lampooned and nicknamed "furcifer" (fork bearer), and London society continued to eat with the fingers.

In France, the fork was first introduced by the *mignons*, or favorite courtiers of Henri III. (1574-1589). The innovation met with much ridicule and little success, for the management of the new toy proved too difficult for most experimenters, who pricked their lips and tongues and scattered more food over their clothes and the table cloth than they put into their mouths. The use of the fork was only a passing fashion. As late as 1680 it had not been adopted in high society, although the king, Louis XIV., ate with a gold fork.

CERIOMYCES SCABER.

The date at which the use of forks became general is very difficult to fix, but it appears certain that in the latter part of the eighteenth century all of the *bourgeois* and many of the aristocrats continued to extract portions from the common dish with their fingers and that, even in the most sumptuously appointed houses, forks were given only to those guests who asked for them. Some guests brought, or sent in advance, their own forks and knives. This custom is not entirely obsolete in some parts of France, and it is still in vogue in a few districts in Germany, Switzerland, and Tyrol. In some of the French provinces, not many years ago, the host at a formal dinner would honor one of his fair guests by requesting her to mix the salad with her hands.

Dr. Cabanès, in a recent work, which contains these and many other details of old-time manners, asserts

BOLETUS SUBSANGUINEUS.

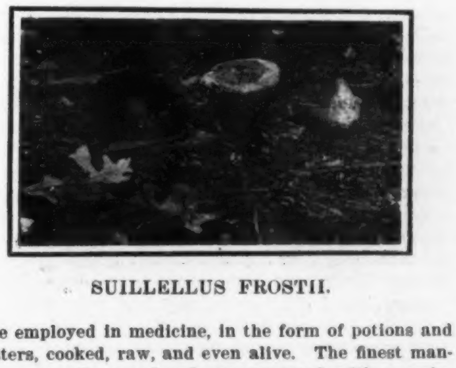
that the cult of the fork has exerted a deleterious influence on the cleanliness of the hands. The custom of putting the fingers into the common dish necessitated frequent ablutions. The hands were washed before eating and, during the meal, they were often wiped with the table cloth, which was undoubtedly invented for that very purpose. A manual of deportment, published in 1766, contains the following excellent advice:

"Always wipe your spoon after using it and before putting it again into the dish, for some persons are too fastidious to eat of a dish into which you have dipped your spoon after putting it to your mouth. If you have the misfortune to burn your mouth lift your plate to your lips, cover your mouth with your other hand and spew its contents on the plate. Take care never to throw anything, except liquids, on the floor. Never dip your bread or meat into the dish or the salt cellar. Do not offer to another person anything which you have tasted. Observe the general rule that nothing which has been on your plate should be returned to the dish."

A guest at a court dinner is counseled "to wash your hands, even if they do not need washing, in the presence of the other guests, before sitting at table, so that those who put their hands into the dish with yours cannot doubt that your hands are clean." This advice was not superfluous. When Queen Christina of Sweden visited France her hands were described by Mme. de Notteville as being "so dirty that it was impossible to see any beauty in them." The Chancelor Séquier "ate with the dirtiest hands that could be seen anywhere," and the Duc de Vendome was so unclean that nobody was willing to sit beside him at table.

If we go back to the end of the sixteenth century we find the etiquette of the table still less rigid. It was correct to dip one's meat in the gravy of the dish. "If others dip their bread in the dish, you may dip yours with propriety. If there is a spoon in the dish, the soup or porridge may be tested with it, but it must be wiped and returned." Here we see the origin of the custom, still observed by some hostesses, of placing intimate friends together. Dabbling in the common dish and licking the common spoon were made more tolerable by this arrangement. When these communistic customs prevailed, however, it was deemed necessary to keep the fingers clean, but this was regarded as a superfluous refinement and the formal washing of the hands was discontinued when the use of the fork became general.

These fine gentlemen of the Renaissance, furthermore, were covered, though not so thickly as their pages and lackeys, with vermin, which, according to Dr. Cabanès,



SUILLELLUS FROSTII.

were employed in medicine, in the form of potions and plasters, cooked, raw, and even alive. The finest mansions, even the royal palaces, swarmed with vermin. The Carthusian monasteries alone were free from them. This exemption has been attributed to the vegetarian diet of the monks but it was more probably due to the fact that the cloisters were kept reasonably clean.—Le Monde Illustré.

PHOTOGRAPHING COMETS.*

WITH SPECIAL REFERENCE TO HALLEY'S COMET.

BY E. E. BARNARD.

Serious injury to, or total loss of, important comet plates may occur by beginning the exposure too early in the evening or prolonging it too late in the morning. Such plates, which cannot be properly developed, would otherwise, with a few minutes less exposure, have made satisfactory negatives. It is difficult to tell when to begin or to close the exposure in such cases. The safest plan would be not to begin or continue the exposure while there is any sky illumination. This is seldom practicable, however, in the case of a bright comet which is never very far from the sunset or sunrise points. Any rules to regulate the beginning or ending of the exposure that would work with certainty would be very valuable. Such rules, however, can only be given approximately, and if adhered to too rigidly might cause the loss of a plate. The position of the comet with respect to the point of sunrise or sunset, the pureness of the atmosphere at the time and freedom from any trace of haze are vital factors in such exposures. The best of all rules is the judgment of the observer at the moment. To one who has had experience in this class of work a glance at the sky will tell him very closely when there is danger. Few observers, however, have had this experience. It is my purpose, therefore, to aid as much as possible those who will need such information. I have tried to formulate some set of rules that would be dependent on the local time and the position of the comet, but these have been finally rejected as dangerous. So much would depend on the purity of the atmosphere at the time, the size and light ratio of the lens, the kind of plate used, etc., that they would probably lead to the very errors against which we wish to guard.

A table like the following will be somewhat of a guide.

Altitude of Comet. Deg.	Depression of Sun. Deg.	Duration of Exposure. M.	Resulting Effect.
30	14–15	90	Little injury.
20	12–13	30	Little injury.
12–13	12–13	30	Somewhat injured.
4–5	11	20	Badly injured, but not ruined.
4–5	11	15	Fair negative.
4–5	11	5–10	Safe.

These refer to the beginning of the exposure in the evening and the ending in the morning skies. It must be remembered, however, that it is the few minutes at the beginning or end of the exposure that will injure or ruin the plate.

On August 3rd, 1907, exposures were made on Daniel's comet with the 10-inch, 6-inch, and 3.4-inch lenses of the Bruce telescope. The crescent moon, which lacked five days of new, is shown on all the negatives only 4 deg. from the comet. The exposure was 1 h. 40 m. The plates, Seed 27 Gilt Edge, are not seriously injured in any case. Fortunately the tail was directed away from the moon. The head was just free from the glare.

In all cases where the plates were marked "injured" (with the exceptions noted below), stopping three or four minutes earlier or in the evening beginning three or four minutes later would have prevented injury. On the dates of 1908 December 9th, 11th, and 13th the entire exposures were on a more or less twilight sky and injury to the plates was unavoidable under the circumstances.

The smaller the lens (if of short focus) the greater will be the fogging effect. This is specially so with the small but rapid lantern lenses.

Moonlight is another source of danger. In a prolonged exposure even a small amount of moonlight is bad. In full moonlight—if the moon is not too near the comet—important results may still be obtained. Much, however, will depend upon the purity of the sky—the purer it is the less will the moon affect the plate. In this case a dew cap helps much. On an ordinary moonlit sky an exposure of a half hour with a quick portrait lens will not ruin a fast plate if not too near the moon. In full moonlight, however, a longer exposure, unless under exceptional conditions, will seriously injure or ruin the plate. With the half hour exposure the plate will be fogged, and of course the best quality of negative cannot be got out of it. Perhaps one of the greatest dangers comes from a combination of dawn or twilight and moonlight.

All plates should be backed to prevent halation. A backing made of sugar and burnt sienna is recommended as entirely satisfactory. This is easily made and can be kept in stock; it will keep indefinitely. The following is the backing that I have used since the eclipse of 1900. The formula was originally supplied me by the Cramer Dry Plate Company.

* Popular Astronomy.

Cook two pounds of granulated sugar in a sauce-pan, without the addition of any water, until it is nearly in the caramel stage. Then stir in one pound of burnt sienna and cook a little longer, stirring well. Do not let the backing reach the candy stage or it will be sticky and disagreeable to handle, and will not soften as readily when being removed from the plate. Finally add about half an ounce of alcohol to each pint as a dryer. Put away in a wide-mouthed stoppered bottle or jar. When needed for use, dilute a little of this with water to the consistency of a thick but not too wet paste. Apply (not wet enough to run) to the back of the plate with a wide camel's hair brush. It is not necessary to back heavily. A sheet of soft paper (old newspaper) pressed onto the backed surface will prevent injury to it. The plates should be freshly backed when ready for use. If kept in stock long after backing, an unequal fogging is likely to occur. Before developing, remove the backing (which will probably still be damp) with a moist piece of absorbent cotton. Any small amount that remains will not injure the developer.

The plates should be carefully dusted with a broad, soft camel's hair brush after being put in the plate holder. The camera tube should frequently be wiped out with a damp cloth to free it of dust. It should also have a tight-fitting cover at the plate end to keep it closed when the plate holder is not in position.

Instead of the single spring used in the back of plate holders to press the plate forward in a constant position, there should be four springs, one near each corner. With such a plate holder there is no danger of injury to the backing.

On account of its greater sensitiveness the Lumière Sigma plate is recommended. Unfortunately this plate has been rather frequently defective in having small round transparent and opaque spots. It is also more subject to "chemical fog" than the Cramer or Seed. Otherwise it is a beautiful and very rapid plate. When the comet is brightest I would recommend Seed 27 Gilt Edge plates on account of their general freedom from defects and finer grain.

The following developer is recommended for both these plates. It was originally supplied to me by Mr. Ellerman:

A.

Water	32 ounces
Sodium sulphite, dry	1 ounce or 2 ounce crystals
Hydrochinon	1 1/3 ounce
Sulphuric acid	30 drops

B.

Water	32 ounces
Sodium carbonate, dry	1 ounce or 2 ounce crystals
Potassium carbonate	4 ounces
Potassium bromide	120 grains

The temperature of the developer should be about 70 deg. F. This developer seems to give a minimum amount of fog with the Lumière plates. It should fully develop in about six minutes, but can be continued for ten or twelve minutes. A longer development will probably prevent the plates fixing out clear, and increase the fog on the Lumière plates.

The surface of the plate should not be wet before developing, as there is then a tendency to form air bubbles during development. As soon as the developer is poured on, the face of the plate should be carefully swabbed with a clean piece of absorbent cotton. As a precaution, in the first part of the development, the plate should be carefully protected from the ordinary dark room red light, especially when removing the backing. In the last stages of development it has lost most of its sensitiveness. Develop until the plate is almost opaque to the developing light. The darkening of the sky should be well brought out. Experience will soon show how far this can be carried—it can easily be carried too far. Do not try to get a negative with a sky of clear glass. For a negative which deals with only the brighter part of the comet, such as the head, a softer developer would be better. Rodinal, in the proportion of about 1 to 50 or 70 of water, with a greater duration of development, will give a very soft transparent negative, especially good for an over-timed plate.

A good fixing bath is:

Hyposulphite soda	8 ounces
Water	32 ounces

To this add about a teaspoonful of bisulphite of soda, which will keep it clear. The plates should be fixed for twenty minutes to insure permanency. The fixing bath should be frequently made new. The plates should be washed for at least an hour in running water.

LENSES, ETC.

There is no question but for the general phenomena of the tail of a comet and for following any outgoing masses that may appear, the portrait lens or doublet, such as is made in this country by the John A. Brashear Optical Company, and the Alvan Clark & Sons Corporation, is the most suitable on account of its larger and flatter field. The wide field Cooke lens is also recommended as specially suited for this work. For the details of the head and the envelopes, the large reflectors are by far the best form of instrument. The two classes of instruments are supplementary and in no way do they infringe on each other's usefulness. The long focus photographic refractor, such as the astrographic telescopes, will be very important where there are no large reflectors because of the greater scale than that of the portrait lens.

There is another class of lenses (and fortunately they are very cheap) that will be of the utmost importance for securing the greater extensions of the tail of the comet. I have called these "lantern lenses" because they are made for the projection of lantern slides. I have used several of these and found them extremely rapid. The best one was made by McAllister, New York, which sold for seven dollars. This was 1½ inches in diameter and of about 6 inches focus. It gave a fair field of some 20 deg. or 25 deg. with full aperture and was very rapid. When cut down to one inch the field was much improved and extended to 30 deg. ± in diameter, and it was still remarkably quick for comets and the Milky Way. This is a useful auxiliary to the larger portrait lens and can be attached on any mounting along with the former. I would recommend this lens (on account of its cheapness) to those who have an equatorial mounting, but are not able to secure a portrait lens or other means of photographing the comet. (See Astrophysical Journal, vol. 18, p. 210.) Should the tail of the comet prove to be of very great length, two of these cheap lenses could be used pointed so that one will continue where the other leaves off, and thus, though in two sections, all of the tail will be secured. Of course, a large portrait lens would be of very great value in making photographs of Halley's comet. Probably, in view of the cost, the most useful size will be about six inches. With such a lens essentially everything about a comet will be shown as quickly as with the larger one. The main advantage of the large lens would lie in its greater scale—which of itself is of great importance. The tube of a small reflecting telescope can also be fastened to an ordinary equatorial refractor. A very successful series of fine photographs of Daniel's and Morehouse's comets was thus secured by Prof. W. A. Cogshall, who attached an eight-inch reflector in its tube to the twelve-inch refractor of the Kirkwood Observatory.

The focus of the lens should be carefully determined. This is done by the aid of star trails and does not require that the camera be mounted. If not on a regular mounting the lens can be propped up to point to the sky—preferably to a region with some bright stars, but really anywhere because there will always be plenty of stars that will trail—with the plate holder adjusted so that it can be moved toward or away from the lens with a rough reading scale. Begin outside (or inside) the assumed focus and expose the plate for one minute. Then change the position of the plate holder toward the lens by, say, 0.05 inch. Again uncap the lens and allow about a minute's exposure. Repeat this until the assumed focus has been well covered on each side, recording the scale reading for each exposure—the camera remaining stationary throughout the work. Let the last exposure be for, say, two minutes (for identification). When it is developed a great many star trails will be seen on the plate. Those near the middle of the series for any one star will be sharp and the others ill-defined. The sharpest one of these will be at the focus, and for use this setting should be adopted. If one examines the trails, which will be found all over the plate, he will find that as they approach the edges the trails that were sharp near the middle are no longer the best defined, because of the curvature of the field. If one adopts the sharpest image near the middle of the plate, he will find that his stars will be very sharp in actual use, but that his field may be rather disappointingly small. In a portrait lens there is always a small allowance in the focal distance over which no change of definition can be detected. If one takes advantage

of this and places his plate just at the limit toward the lens, he will decidedly increase the extent of his usable field, while if he goes to the other limit he will decidedly decrease the extent. It is therefore important to keep the plate as near the lens as will give good definition in the center. If at any time the image should show a want of good focus at the middle with a ring of better definition away from the center, the plate is too near the lens and should be placed slightly farther away. If it is slightly out of focus at the middle with a small field of fair definition, the plate is too far from the lens. A little care will thus enable one to find the best focus that will give the widest possible field with the lens.

All commercial plates are more or less curved. It is the custom to put the emulsion on the concave side. This improves the flatness of the field. Once in a while, by accident, the emulsion is put on the convex side. This, of course, is very bad if the plate is much curved. It throws the sensitive surface too near the lens and an out-of-focus plate is obtained. Whenever a question of change of focus comes up, the plate should be examined to see if the trouble does not lie with it, before any change of setting is made. With a lens of six inches aperture, or less, there is very little change of focus due to temperature.

It is specially important that the focus of the lantern lens be determined by some means like the above, for it will differ from the visual focus that would be obtained by focusing on a ground glass.

It is difficult to tell beforehand what exposure times will be necessary in photographing Halley's comet. That point can be settled later by actual experience or by inference when something is known of its spectrum. The exposure times necessary on Daniel's comet of 1907 and Morehouse's of 1908 were very different. The latter, though visually a much fainter object, was far quicker in its photographic action. The spectrum of the comet, however, showed that its light was almost entirely actinic. When at its brightest an hour's exposure or less with a portrait lens was ample to show essentially all the features of the tail.

To secure the greatest extent of the tail it will be necessary to so point the camera with respect to the guiding telescope that the head of the comet, when behind the guiding wires, shall be near the edge of the field of best definition in the camera with the tail stretching across the plate. By this means as much as 4 deg. or 5 deg. more of the tail can be shown without injury to the definition of the head than when the telescopes are parallel. This is easily accomplished, when the camera is fastened on to an equatorial, by tilting the camera in the right direction—to the proper angle—and firmly wedging it in position. This, of course, will need to be changed when required by the change of the comet's position. An additional tube to carry the object glass and guiding eyepiece of the regular guiding telescope is temporarily mounted on the main tubes of the Bruce telescope of the Yerkes Observatory, with an allowable adjustment from the parallel of the system of four degrees in any direction for comet work. When no active comet is present, this tube is removed.

A "dew cap" some eight or ten inches long (not long enough to cut off any of the field) will be valuable not only in case of dew forming, but also to cut off outside sky illumination which would otherwise tend to fog the plate.

Several different cameras should be used. These, especially the smaller ones, can be attached to the tube at suitable points so as not to interfere with each other. A good plan, when the conditions will permit it, is to keep one or more of the cameras exposing while the plate of one is being changed, so that the times will overlap. Interesting results will thus be obtained if the comet is changing very rapidly. For instance, if two hours' exposure be given with the larger lens, two exposures of one hour each can be given with the smaller and supposedly quicker lens.

As to the question of guiding: if the comet has a definite condensation to guide upon, it is safer to bisect this with the guiding wires. Instead of guiding on the comet, Dr. Joel H. Metcalf uses a fixed star for this purpose. The cross-wires, set to move in the path of the comet, are given at short intervals a motion in the contrary direction but equal in amount to that of the comet, the star being kept bisected by the cross-wires in the meantime. This, if there is no mistake in the above quantities, will of course keep the comet fixed on the plate if not affected by differential refraction. Should any mistake occur, and we find such to have been the case even in the hands of a skilled observer on several dates in 1908, the comet will not remain stationary on the plate (see Popular Astronomy for November, 1908, vol. 16, p. 575). The safest plan, where a guiding telescope is used, is to guide on the comet itself, if possible. If illuminated wires are used, the illumination should be so adjusted as to make the wires as faint as will just permit their being seen on the comet's head. To those who do not have the proper illumination for the spider lines, fine copper wires will serve well when the comet's head is bright enough to show them in black relief.

When guiding on the head of the comet, a careful watch should be kept for any pulsations that may occur in its light. (See Astrophysical Journal for December, 1908, p. 385.) If there should be considerable changes the exact time of their occurrence should be recorded.

The method of guiding on a star and allowing for the motion of the comet seems to have been successfully used at Greenwich with their large reflector where the exposures were very short. Perhaps it is the best method with such an instrument. It would be absolutely necessary in the case of a comet where a guiding telescope is not used, or in the case of a double-slide plate holder.

It is scarcely necessary to call attention to the importance of the time element in photographs of comets. The beginning and ending of the exposure should be carefully noted and the correct time be used, so that if necessary the exact moment of exposure may be known if called for later on. Of course a record as to any noticeable changes in the transparency of the sky during the exposure is important.

Sometimes the original negative of a comet has not sufficient contrast to print or even enough to permit good glass positives to be made. All the strength required can be obtained by making a second negative. To do this, make the best glass positive possible from the original negative. From this positive, make a second negative. It will be found that all the contrasts will be accentuated in this negative which will give a print with all the strength required. If the original negative is very weak, a slow plate, say Seed 23 or Seed Process, can be used for the second negative which will give the required contrast. In general, it is best to use a fast plate, say Seed 27, for the second negative or the contrasts will be too harsh. With such a plate, soft but strong negatives are secured from which prints or glass positives of an excellent quality can be made. Any amount of density can be had by making a third or even a fourth negative if necessary. I have used this method of strengthening astronomical photographs for the past twenty years. It is far preferable to an attempt to intensify the original negative.

A good developer (such as is used at the Yerkes Observatory and which was introduced there by Mr. Wallace) for glass positives is the following:

A.

Water	60 ounces
Hydrochinon	1 ounce
Potass bromide	½ ounce
Sodium sulphite, dry 3 ounces, or crystals	6 ounces

B.

Water	60 ounces
Potass. caustic	2 ounces

The temperature of the developer should be about 70 deg. Fahr. For use, take one part each of A and B with one part of water. The development should not be continued more than five or six minutes or the plate will not fix out. The positives should be made (either by the camera or by contact) on ordinary transparency plates, or on Seed 23 or Seed Process, both of which latter plates give excellent positives.

In making contact positives, where the exact size of the original is required, a good light to use is that from a Rochester oil lamp with a white porcelain shade. I find that the best results are had by examining the negative by this light, holding it at various distances from the lamp. If the plate is weak or thin, it will be seen that as you recede from the lamp the negative appears in better contrast. At a certain point it will appear best. This is the point at which the plate should be held when making the positive—nearer the light or farther away the results will not be so good.

There is one class of defects that sometimes comes on a negative or positive in the drying, or later by accident, about which I have not seen anything written. If a negative is wet again after it is dry, "tears" will probably form in the drying. Sometimes they occur in the original drying of the negative. These often leave semi-transparent markings. If examined closely, it will be seen that the film is thinner at these points or they will appear as slight indentations. By accident I found the remedy for these. Thoroughly wet the negative again. The markings will disappear at once. To prevent a repetition of the trouble remove all the water from the film carefully with absorbent cotton before putting to dry. Usually if drops of water get on a plate when dry, they will cause these peculiar markings. Of course, the remedy is the same as before. If a negative happens to be near a window and fine snow is blown in on it, wherever a speck of snow touches the plate a minute transparent speck will appear so that the picture will be full of pin-holes. Examined with a glass these usually appear like small craters with raised walls. They are removed instantly by immersing in water as in the other cases. If the surface of the negative has been injured by being rubbed or slightly scratched, the abrasions will show on a print. The "water cure," however, will effectually remove these from the negative if the film has not been cut too heavily. I make mention of these facts because the simple remedy does not seem to be generally known even among those who have had great experience in photographic work.

MECHANISM OF VOLUNTARY ACTION.

Many movements of lower animals, which have hitherto been regarded as voluntary, are due to tropisms, i. e., directive influences of external stimuli, in which sensory impressions and their voluntary or involuntary reactions play no part. Influences of this character are exerted by light (heliotropism), by electricity (galvanotropism), and by gravity (geotropism). For example, the heads of winged plant lice turn automatically toward a source of light. If the light falls on one side of the insect, the muscles which turn the head and body are subjected to greater tension on the illuminated than on the dark side, and the head is consequently turned toward the light. When this movement has been accomplished the muscles on both sides are equally illuminated and exert equal tensions, so that no further turning movement occurs. Hence the insect is automatically guided to the light, as a stone is caused by gravity to fall vertically. The only difference is that gravity acts directly in guiding the falling stone, while the light affects the movement of the insect indirectly, by accelerating chemical transformations.

Many animals which ordinarily do not exhibit heliotropism can be made heliotropic artificially. Crabs are made abject slaves of light by an addition of carbon dioxide to the water in which they live. In pure water crabs pay no attention to a light, but in carbonated water they move toward it as directly as their imperfect method of swimming allows. In ants and bees the union of the sexes is accomplished during the "wedding flight," which is always directed toward the sun. This is the result of a temporary positive heliotropism which is developed in the perfect females and males at the breeding season and attains its culmination at the epoch of the wedding flight.

All of these heliotropic phenomena are determined by the relative velocities of chemical transformations simultaneously taking place in superficial elements symmetrically situated on opposite sides of the body. The tropisms which are caused by electric currents, gravity, and chemical reagents are brought about in an analogous manner. In these cases, therefore, it is already possible to refer the movements to simple physico-chemical relations, and thus to analyze psychological phenomena by means of physical chemistry.

Prof. Jacques Loeb, of the Berkeley University, California, set forth these relations in detail in his address to the sixth international congress of psychologists at Geneva. The concluding portion of this address was substantially as follows: "I believe that the study of the conditions which produce tropisms may be of importance in psychiatry. The development, in an animal normally insensitive to light, of a heliotropism which drives the creature irresistibly into the flame, by the agency of acids or of secretions of the reproductive glands, is in my opinion a fact upon which analogies applicable to psychiatry can be experimentally founded and investigated. These experiments may be equally valuable in the study of ethics. The highest stage of ethical development, in which men are ready to sacrifice their lives for an idea, is inexplicable either from the utilitarian standpoint or from that of categorical imperative. It may be that, under the influence of certain ideas, chemical transformations, i. e., internal secretions, are produced which so increase the man's sensitiveness to certain stimuli that he becomes the slave of those stimuli, as crabs become slaves of light. The notion that an 'idea' is a process which may produce chemical actions in the body no longer appears startling, since Pawlow and his pupils have succeeded in producing a secretion of saliva in dogs by means of optical and acoustical stimuli."—Umschau.

The vacuum vessel introduced by Dewar has proved of such value as a means of improving the thermal insulation of bodies that it is no surprise to find it introduced into calorimetry. At the suggestion of Prof. Nernst, of the University of Berlin, Dr. H. Schottky has carried out a series of measurements with a modified form of Favre and Silbermann calorimeter, in which the mercury was replaced by pentane, and the bulb of the calorimeter surrounded by a vacuum vessel. The instrument looks like a Bunsen ice calorimeter using pentane instead of ice, and having a vacuum vessel around its bulb. It has proved a great improvement on its predecessors, and is considered by Dr. Schottky to be extremely accurate.

ENGINEERING NOTES.

The introduction of labor-saving machinery on the farm has been one of the principal features of the modern revolution in agriculture, and has been rendered necessary by the difficulty of getting sufficient help. Few contrivances are more interesting than the milking machine. A lengthy test has been made at the Wisconsin Agricultural Experiment Station, and is recorded in Bulletin No. 173. The machine worked more quickly and more cheaply than a man; it yielded a cleaner milk, which therefore kept better, and, finally, was shown to have no injurious effect on the udders or the general health of the animals. The machine, of course, requires proper attention and careful working to get the best results, but proved decidedly economical in herds of thirty cows or more. There are already signs that the agricultural laborer of the next generation will be, in the main, an engineer.

A 30-inch cast-iron water main laid on a timber trestle in Devereaux Street, Philadelphia, was lowered last autumn to low concrete piers by the Bureau of Water, in connection with the grading of the street. The section lowered had a total length of about 1,100 feet, and the trestle was 27 feet high. The supply was shut off and the pipe cut into two sections, each approximately 550 feet long, so that the work was done in two successive operations. The trestle was of a simple two-post type, the bents being cross-braced and having diagonal bracing running longitudinally from bent to bent. A gallows frame was erected on top of each bent over the first half of the pipe to be lowered, and was fitted with a screw long enough to reach the final resting place of the pipe. The screw was held by a nut, bearing on the top of the gallows frame, and having two handles. The lower end of the screw was attached to a strap passing under the pipe. Two men were placed at each screw, and the entire 550 feet of pipe lowered simultaneously.

What is said to be a record achievement in the movement of a heavy freight train has been accomplished on the Pennsylvania Railway between Altoona and Encola, near Harrisburg, Pa. To determine what could be done in actual road service, as the result of some of the company's recent expenditure for improvements, 85 steel gondola cars, loaded with a total of 4,451 tons of coal, were on June 14th attached to a freight engine of the most improved type. The total weight of the train was 6,151 tons, and its length from the pilot of the locomotive to the rear platform of the cabin car was 3,000 feet—nearly three-fifths of a mile. The run of approximately 124 miles was made in 7 hours 15 minutes, the average speed of the train being 17 miles per hour. The company had made a number of road tests previously, but this performance surpassed all others. These runs were made possible by the fact that the company has now reduced all gradients and compensated all curves on the middle division of its main line between New York and Pittsburg, so that the ruling gradient there is less than 12 feet to the mile. Formerly it was necessary to have a "pusher," or extra locomotive, to assist long freight trains over the heavy gradients. Now it is possible for single locomotives unaided to accomplish these record results.

The rating of gas engines is likely to be one of the subjects which will shortly receive the attention of the American Society of Mechanical Engineers or some other body equally competent to settle the matter in the same way that the Centennial Committee settled the rating of steam boilers. The gas now used in internal-combustion engines ranges in calorific value so very widely that it is out of the question to be satisfied with a statement of engine efficiency on a basis of the volume of gas consumed, even if the volume is expressed as at a standard pressure. It is quite customary to speak of the efficiency of a gas producer and engine plant in terms of pounds of coal per horse-power hour, but this is unsatisfactory because the thermal value of the coal ranges very widely, and as experience is gained in the use of cheap grades of lignite, this range is becoming still greater. A way out of the difficulty would be the adoption of the thermal value of a gas reduced to a standard gas pressure as the basis of comparison, but the determination of the thermal value of a gas, while not so troublesome as the determination of the value of a sample of coal, is likely to be enough of a bother to prevent any really serious general adoption of the method. It is well known that the automobile engine makers were puzzled over this subject for some time, but rules have finally been agreed to which are essentially empirical, but give pretty fair average results when using gasoline as a fuel. It is not unlikely that as experience is gained with the use of large gas engines, some such method of rating them will be adopted, although it will throw on the purchaser more technical responsibility than he assumes when he purchases an engine under a guarantee that it will have a certain horse-power with a stated consumption of a given fuel.—Engineering Record.

SCIENCE NOTES.

One of the largest deposits of zinc in North America is that known as the "Big Ledge," on the upper face of a mountain above Arrow Lake, British Columbia. The ore is in the nature of "black-jack," averaging 30 per cent to 40 per cent zinc. The deposit has been traced over three miles, with a width of 50 feet to 100 feet. So far no development work of importance has been done on it.

In Scotland and New Zealand, where there are no known petroleum deposits, a remarkable substitute has been found in the existence of immense deposits of bituminous shales. These have been milled and distilled for oil, and for a great number of secondary products. The works have been running for many years in both countries, and a thriving business has been established and many millions added to the public wealth.

The history of pure mathematics shows that many of the most important branches of the subject have arisen from the attempts made to get a mathematical solution of a problem suggested by physics. Thus the differential calculus arose from attempts to deal with the problem of moving bodies. Fourier's theorem resulted from attempts to deal with the vibrations of strings and the conduction of heat; indeed, it would seem that the most fruitful crop of scientific ideas is produced by cross-fertilization between the mind and some definite fact, and that the mind by itself is comparatively unproductive.

Speaking of the medical uses of radium, Sir William Ramsay recently said: "It is known already that the disease rodent ulcer has been cured by radium compounds. It has been tried for cancer, but so far the results are not encouraging. One case treated by radium shows improvement. That is as far as I can go. Radium has been found useful in skin diseases. Of course the whole subject is just at the beginning, and the object of the Radium Institute in London and similar institutes throughout the world will be to investigate the curative power of radium more thoroughly."

The velocity of falling raindrops has been measured by Schmidt with an apparatus consisting essentially of two horizontal plates of sheet zinc attached to the ends of a vertical shaft about 8 inches long. A sector of the upper and larger disk was cut out and the lower disk was covered with filter paper strewn with eosin powder. The apparatus was set into uniform rotation and exposed to the rain. The only drops that can reach the lower disk are those which have fallen through the open sector of the upper disk. Meanwhile the disks have moved so that the wet sector of the lower disk is not vertically under the open sector of the upper disk, but is displaced through an angle which depends on the velocity of the falling drops. The size of the drop can be estimated from the size of the circular stain which it makes on the prepared paper. In this way the diameters and velocities of more than 3,300 rain drops were determined. The diameters ranged from 3.5 to 0.4 millimeters (0.14 to 0.016 inch) and the velocities from 7.4 to 1.8 meters (24.3 to 5.9 feet) per second. The velocities of the smallest drops were found much smaller than the values previously assumed.

Lime plays an exceedingly important part in the growth of young animals, and a deficiency of lime in their food may produce the morbid condition known as rickets. Aron finds that a new-born infant needs a supply of lime equal to a little more than one per cent of the increment of its weight. Human milk contains 0.06, 0.04, and 0.035 per cent of lime during the first, second, and third months of lactation, and 0.03 per cent during the succeeding months. From these percentages of lime and from the daily consumption of milk and increase in weight it is calculated that the quantity of lime furnished by the mother's milk is slightly more than sufficient for the infant's needs during the first three months and just sufficient thereafter. This equilibrium is very unstable and may be disturbed either by a diminution in the lime content of the milk or by intestinal troubles which prevent the assimilation of the lime furnished. Although Pfeiffer found the normal percentage of lime in the ash of the milk of mothers of rickety children, it is generally observed that the milk of such mothers contains less than the normal proportion of ash to total organic matter. Hence the infant obtains sufficient organic nutriment for its growth, but the new tissue is of inferior quality, because it is deficient in lime. In the case of animals which develop rickets in consequence of an insufficiency of lime in their food, experience proves that it is easier to prevent rickets by adding lime to the food than to cure the disease after it has appeared. Helen Stoeltzner finds that oxide of strontium, added to animals' food deficient in lime, is assimilated and deposited in the bones, but it does not entirely take the place of the missing lime. The bones of the animals become diseased, although their condition is different from that which is characteristic of rickets.

TRADE NOTES AND FORMULÆ.

Varnish for Securing Transfer Pictures to Earthenware Goods.—13 parts of mastic, white rosin 25 parts, Venice turpentine 54 parts, sandarac 50 parts, 98-degree alcohol 160 parts, dissolved at a moderate heat.

To Make Burned Alum.—Heat, with constant stirring, ordinary alum (alumina alum) in an iron pan, in which at first it will melt quickly and then begin to raise bubbles. Heat it until a dry, white mass, of a loose character, remains, which should be pulverized and kept in carefully closed glasses.

Acetone Varnish.—Finely powdered copal 100 parts, dried at 248 deg. F., is placed, while still hot, in a vessel that can be tightly closed, over which pour 280 parts of acetone, which will produce, after solution, a varnish that will dry very rapidly and which gives a fine glossy coating to paper (maps, copper plate prints, etc.). By the addition of highly rectified alcohol, the varnish may be made to dry more slowly.

Albumen Clarifying Paper.—Dip sheets of unsized paper in beaten and re-settled white of egg, and hang them in the sun to dry, repeating the dipping and drying several times. In order to fine wine, liqueurs, or any other fluid with the aid of this paper, tear a suitable quantity of it into small pieces and stir it into a portion of the fluid to be fined. Owing to the albumen with which it is coated, the paper has a clarifying effect.

Alkarazza is the name of vessels of very porous earthenware which, when filled with water, are always moist outside, and owing to the evaporation of the water on their surface, always keep their contents cool. Alkarazza can be made from any good potter's clay, by mixing with it 10 per cent of its weight, dry, of very fine sawdust and then working it. On burning, the sawdust is destroyed and the clay thereby left porous.

Albolith (Plastic Mass).—Magnesite is reduced to pieces as large as a fist, and burned in a retort furnace. The burned magnesite is ground in a roller mill, screened through sifting cloth and thoroughly mixed with suitable quantities of amorphous fossil meal (infusorial earth). Mix with water and moderately strong solutions of chlorides, for instance chloride of magnesium. After setting it heats spontaneously, so that where glue molds are used they must be previously detached.

Cement for Repairing Stoop Steps.—A preparation for this purpose consists of a fairly soft mixture of cement lime with potash water glass, to which a little finely-sifted river sand is added. The proportion of cement lime to river sand is 2 to 1. The worn steps do not, as usual, require to be chiseled out. The above described freshly prepared mass is applied to the defective spots, previously moistened with water-glass, in such a manner as to restore the proper shape. This is best effected by a practical mason. The mass dries inside of six hours and becomes as solid sandstone.

Natural and Durable Lemon Juice.—In the spring the juice is expressed from peeled and cut up lemons, strained through a cloth and then added to the extent of ¼ of its volume to powdered talcum (which has been previously treated with dilute ClH and washed with water). The well shaken up mixture is allowed to settle, filtered through paper, and to the filtrate 10 per cent of sugar added, after which, in a brightly-polished tinned vessel, it is brought to a boil. The fluid is poured hot into bottles, closed with cork stoppers previously dipped in paraffine.

The Production of Absolute Alcohol.—1. Heat in a porcelain vessel, finely pulverized blue vitriol, stirring it with a copper spatula until the powder has become white. Then place it in an hermetically-sealable vessel and allow it to cool there. Over 1 part of the powder, in a roomy glass vessel, pour 10 parts of highly rectified spirits, free from fusel oil, and allow it to stand for 6 hours, shaking frequently. The alcohol is then free from water, the vitriol having taken up the water. The blue vitriol can be again rendered anhydrous by heating, and so forth. 2. High per cent spirits, free from fusel oil, are redistilled repeatedly over freshly burned quicklime.

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